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TELECOMMISSION studies

STUDY 8(a)

PROBLEMS RELATING TO THE REGULATION OF PRIVATE LINE SERVICES

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This Report was prepared for the Department of Communications by a project team made up of representatives from various organizations and does not necessarily represent the views of the Department or of the federal Government, and no commitment for future action should be inferred from the recommendations of the participants.

This Report is to be considered as a background working paper and no effort has been made to edit it for uniformity of terminology with other studies.

FOREWORD

This document includes three reports. Part One contains the report from Canadian National/ Canadian Pacific Telecommunications; Part Two contains the report of the Trans-Canada Telephone System; and, Part Three contains the report prepared by an "In-House" project team comprised of members from federal government departments and agencies.

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PART ONE

REPORT OF

CANADIAN NATIONAL/CANADIAN PACIFIC TELECOMMUNICATIONS

1) INTRODUCTION

Back Ground

To date, regulation of the Telecommunications Service industry in Canada has been limited to public telephone and telegraph services, services that traditionally have been viewed as monopolies. However the Canadian Telecommunications Carriers also offer a variety of other services, which have not been subject to regulation and have evolved in a competitive environment.

Developments in the Telecommunications Service industry have raised issues concerning the wisdom of the Telecommunications Carriers providing regulated monopolistic services and other services which are not regulated. Accordingly, amendments to Federal legislation will come into force August 1, 1970 to provide for regulation of all Telecommunications Services offered by Carriers which fall under Federal jurisdiction.

The action to regulate all services was taken with the knowledge that the issues surrounding operation of the "other services" would be the subject of this study by the Telecommission.

Scope and Limitations

The study of problems relating to the regulation of the Private Line Services inevitably involves broader issues: the question of competitive versus monopolistic means of supply and the type of regulation

that should be applied to the total Telecommunications industry. As these matters are being covered in Telecommission Study 7 (a)(b), the scope of this study is limited to the examination of specific matters related to the regulation of Private Line Services and other services not regulated prior to August 1, 1970.

The terms of reference are:

1) A definition of the scope of the study and review of some of the "private line" services offered by the carriers and an overview of relevant financial and commercial characteristics.
2) Reference to private line technology, present and future, with a view to identifying its relationship to the study.
3) A description of the regulatory situation relative to private line services in Canada.
4) An identification of problem areas faced by both the users and suppliers of private line services.
5) A presentation of some of the basic regulatory alternatives with respect to private line services, and a discussion of how these would contribute to the solution of problem areas. (i.e. a definition of the various possible objectives of regulation).
6) A presentation of points of view that favour, or do not favour, regulation of private line services. This will serve to identify potential problems and benefits arising from regulation.

7) An examination of the probable impact of regulation of private line services on the telecommunication common carriers and upon the industries environment (e.g. users, regulatory bodies, government policies, etc.).

8) Recommendations concerning the regulation of private line services in Canada.

Note - The reference to satellites within the original terms of reference has been deleted as confirmed by the Liaison Officer.

This study is being undertaken by three groups, an In-House project team comprised of representatives of Government Departments, and the Telecommunications Carriers with each carrier group submitting independent reports. The In-House project team has prepared an interim report and for ease of comparison this submission by CN/CP will insofar as possible use the same format.

2) TELECOMMUNICATIONS SERVICES PROVIDED BY CN-CP

The "in-house" study group initially proposed a definition for "Private Line Services" as "those telecommunication services which are provided to a customer by means of facilities that are exclusively dedicated, for any period of time, to serve his telecommunication requirements". This definition does not, in fact, exclude public telephone service as provided today in that this service also utilizes facilities that are exclusively dedicated to the user for a period of time and would include Telex which in our opinion is a public service.

Assuming that a definition is required for the Telecommunications Services to be reviewed within this Report, namely services not regulated prior to August 1, 1970, it may be more appropriate to differentiate between Private and Public (Telecommunications) Services. We consider a Private Service as a telecommunications service which provides for the exchange of traffic between specified subscribers to the service, as opposed to a Public Service which provides for the exchange of traffic between any subscribers to the service. A private service can be provided to a customer by means of facilities which are exclusively dedicated (non-switched) to his use. This is perhaps a more satisfactory description of a "Private Line Service". However, the term has been generally applied to

all private services including those that are provided by means of shared switched facilities so arranged as to restrict the exchange of traffic to specified subscribers.

Although a full range of Telecommunications services are offered by CN/CP, major offerings can broadly be classified as

- Dedicated Private Line Services;

  Voice, digital record, facsimile, broadcast (audio, video).

- Line Switched Services;

  Telex, Data Telex, Broadband Exchange Service, and "Hot Line" Telephone Service.

- Message Switched Services.

We consider the above as private (line) services except for Telex (and Public Telegram Service not covered by this Report) which by our definition is a public service. Nevertheless as Telex is currently a non-regulated service it is included for review within this report. All of the above services, including Telex, are competitive with services offered by the Telephone Companies.

Dedicated Private Line Services

These Services evolved to satisfy the need to transfer large volumes of traffic between limited numbers of fixed correspondents; a need that was not economically or practically feasible through the use of public telephone or telegram services. At this time the majority of

such services are intra-company voice services and record services operating at low speeds (Teleprinter) although services are available for a full range of transmission capabilities. They use terminal equipment and interconnecting facilities on an exclusive use basis. Charges consist of monthly rentals for terminal equipment and rentals for circuits connecting such terminal equipment at rates related to distance for specific periods of time and to type of service necessary to meet customer requirements, in accordance with published tariffs.

Special Private Line Services

There are variations of the above services which are established on a contractual basis (at prices which may be different from published tariffs) to meet a subscriber's specific requirement. These may involve contributions by two or more parties including the subscribers. Two examples serve as illustrations:-

1. Program Transmission Service (Video and Audio)

   These are private services provided by means of facilities specifically designed (high quality) for the transmission of Audio and/or Video broadcast network services between specified points. Where facilities are required full time such as for CBC and CTV network service, service is provided on a contract basis for a specified term. When required occasionally, service is provided in accordance with published tariffs related to distance, time and the quality of service required.

2. Stock Market Quotation Services

These are services provided on a contractual arrangement involving participation by stock and commodity exchanges, Telecommunications Carriers and subscribers. They provide for the distribution of stock or commodity exchange market quotations to member firms or other approved recipients. Generally the exchange and the carrier agree on the amount to be charged subscribers to the service, depending on the distance from the exchange, in the form of a flat monthly charge, and agree on a settlement between themselves. The carrier provides the terminal equipment in the subscriber's office but may permit the subscriber to connect other terminal devices with appropriate adjustments in charges.

Line Switched Services

These are switched services, providing for direct connections between equipment situated in subscriber's premises. Service is provided by means of exchanges centrally located to serve specific communities and linked together by common trunk groups which enable a subscriber to share trunk circuits with other subscribers although, while connected, he has the exclusive use of the circuit allocated to him in the selection process. The service is designed to meet the needs of users with a requirement to communicate with a large number of correspondents or a limited number of specific correspondents at

a volume level which makes dedicated Private Line Service uneconomical. Subscribers to these services pay a fixed monthly fee for the exchange connection and the terminal equipment, plus a toll for each call made, based on the circuit holding time and the distance between the points of origination and destination. Public telephone service is a line-switched service and while CN/CP do not provide public telephone service except in certain areas of Newfoundland and the North West Territories, CN/CP do provide a variety of similar services as follows:-

Telex

Telex is a line-switched service for teleprinters operating at a speed of 50 bauds. It uses telegraph long line plant designed to occupy the minimum amount of frequency space to provide satisfactory transmission at this speed. Subscribers are charged for this service as described above except that there is no minimum toll charge. Service is provided by CN/CP throughout Canada and is available throughout various parts of the world. At present there are approximately 20,000 Canadian subscribers who can communicate with each other as well as with approximately 29,000 subscribers in the U.S.A. Overseas subscribers bring the total to approximately a quarter of a million subscribers.

Data Telex

Data Telex is a similar service to Telex except that it is designed to operate at transmission speeds up to 180 bauds over appropriate

line facilities. As opposed to Telex, terminal compatibility is not required by CN/CP so that complete connectability between all subscribers is not available. There are approximately 400 customers using this service.

Broadband Exchange Service

Broadband service is provided on a line-switched network specifically designed for simultaneous two-way data transmission on circuits of various bandwidths up to 48 KHz. At present the network is only equipped with specially conditioned voice grade circuits (nominally 4 KHz) and is handling data transmissions at speeds up to 4800 bauds. The wider bandwidths will be added as soon as the demand develops. Since terminal compatibility is not required by CN/CP, complete connectability between all subscribers is not available. Since voice quality facilities are used, telephone services are available but are not offered as a public service. There are however a number of special features available on Broadband such as abbreviated dialling, hot line, and conferencing, which make this network attractive for private telephone service. Furthermore, because of restricted access it does not suffer from the over-load conditions which can occur on the public telephone network, particularly during emergency conditions. Subscribers are charged for Broadband service, as described for all line switched services, except that there is a 30 second minimum toll charge.

As wider bandwidths are added and the subscriber has the ability to

select the bandwidth of his choice, tolls will be related in the future to his bandwidth selection. While service is presently limited to larger communities, extensions to other locations in Canada may be subject to special conditions. There are approximately 500 subscribers to this service.

"Hot Line" Service

"Hot Line" service is a private telephone service by means of which instantaneous connection between two particular correspondents is achieved when the originator takes his telephone "off-hook" (no dialling). While this type of service is available on Broadband there are economies in providing "Hot Line" service as a special service where there is sufficient demand for this unique telephone service. In this situation service is provided by means of pairs of special switches between specific locations interconnected by voice grade trunks. Service is only provided at this time between Montreal and New York and between Toronto and New York. Subscribers pay a fixed monthly fee for connection and toll charges based on holding time and distance.

Message Switched Services

These are services provided for record transmission using store and forward switching (computer oriented switches) as opposed to line switching techniques. Incoming lines are connected to computers which store complete messages or parts of messages and forward them in accordance with prescribed routing information to the point of destination or an adjacent switch as outgoing lines are available. A variety of service options are available such as code and speed translation, multi-addressing, message retrieval and accounting. At this time services are oriented to private use and have been provided on a contractual basis. In view of the variety of special requirements this practice will be continued. It is intended in the future to offer a public Message Switched service. At that time tariffs will be published to cover public offerings.

Significance of Technology

It is important to understand that the above descriptions are general in nature and within each category, special services exist that are "custom designed" to meet specific requirements of customers, industries or groups of industries. These special services are becoming increasingly important to meet the more sophisticated demands of the Canadian telecommunication user. CN/CP takes pride in the fact that it has been able and will continue to use technological developments to the fullest extent in the provision of new and improved

Telecommunications Services and to adapt these services to meet the special requirements of its customers.

It is abundantly clear from the types, quality and quantities of services in Canada today, as compared to those available a few years ago, that technology has played a significant role in the development of the Telecommunications Industry and will continue to do so in terms of the Carrier's ability to provide new services and maintain tariffs at lower levels than would otherwise be possible.

Provision of Service

As a Telecommunication Carrier, CN/CP recognizes an obligation to provide and continue to provide services required for any legitimate purpose throughout Canada within areas where it generally provides such services. Where suitable distribution facilities are available, CN/CP undertakes to provide service upon application with all reasonable despatch. Where suitable facilities do not exist, it is prepared to provide service if there is an effective demand (i.e. demand at compensatory rates). In this regard, CN/CP constantly examines market potentials in areas not currently served to determine the economic feasibility of extending any or all services into such areas at standard tariffs.

Revenues

It is important in an examination of CN/CP operations to note the relevant significance of its various service offerings in terms of

gross revenue. The following is a rough breakdown of these revenues for 1969.

- Private Line, Public Telegram and Telephone services	$ 37,300,000
- Telex and Data Telex	30,300,000
- Broadband Exchange Service	1,000,000
Total	$ 68,600,000

NOTE

Revenues from Hot Line and Message Switched Services were not significant in 1969 as these are relatively new services.

While the revenues derived from Public Services have not been separated, it is significant that the unregulated portion of CN/CP services represents approximately 76% of CNT's and 82% of CPT's gross revenues. Under the circumstances, the type of regulation coming into force on and after August 1, 1970 will have far reaching affects on CN/CP's operations.

3) THE CANADIAN REGULATORY ENVIRONMENT

The history of regulation and the current regulatory settings are subjects of review by Telecommission Studies 1 (b) and 7(a)(b). It is important however for an appreciation of the following section, to summarize the present situation.

In Canada regulatory control for Telecommunications Carriers is exercised both Federally and Provincially. To date Federal regulatory powers have vested with the Canadian Transport Commission (CTC). Provincial Carriers are generally regulated by their local authorities. Bell Canada, Canadian National Telecommunications, Canadian Pacific Telecommunications and the B.C. Telephone Company are all subject to Federal control.

As an exception to the climate of divided control, adminstration of the radio frequency spectrum is exclusively under the jurisdiction of the Federal Minister of Communications.

Effective August 1, 1970 the jurisdiction of the C.T.C. will be broadened to include most services offered by the Telecommunications Carriers over and above the public telephone and telegraph services. As this enlarged jurisdiction is just about to be implemented its impact on the Canadian Telecommunications Industry is unknown. The criteria by which the C.T.C. will exercise control are, by and large, uncertain and insufficient and the problems resulting from split jurisdictional control (Federal/Provincial) have yet to be resolved.

4) STRUCTURE OF THE TELECOMMUNICATION INDUSTRY

The purpose of this study is to review the consequences of regulation of private line services and other services which were not regulated prior to August 1, 1970, as it affects the users and suppliers of such services. In our opinion this cannot be done in isolation from the broader positions taken in respect of the total industry and documented in other submissions. It must recognize national objectives and the structure of the Telecommunications (Service) Industry to arrive at recommendations concerning the regulation of a particular segment of the total operation.

CN/CP has developed relevant positions in reports on Telecommission Studies 7(a)(b) and 8(b). These developments will not be repeated herein but may be summarized as follows.

Where telecommunication service needs require access on demand to any one of millions of points, i.e. to any one of the subscribers to the service, special considerations relating to system optimization, integrity and reliability apply that make a case for monopoly in public service. In all other circumstances the telecommunication services can be more responsively and efficiently handled by competing suppliers.

Because the Telecommunications Industry is capital intensive and

becoming increasingly so as a result of the high rate of technological developments and obsolescence, and because of the inherent economies of scale, the organizational choice for the industry must be a mix of limited competition and monopoly.

The present structure of the Telecommunications Industry consists of essentially two competing groups, CN/CP Telecommunications as one group and the Telephone System which includes Bell Canada and provincial and regional telephone companies as the other. This limited carrier configuration has performed well and met Canadian needs with wide availability of essential services at acceptable prices for the user, and should be maintained. There is sufficient business to support these two carrier groups and no evidence to suggest that they will not adequately meet the anticipated needs of the future, given certain changes to strengthen and reinforce the competitive situation.

Accordingly CN/CP contend:

1) There should continue to be a monopoly in public telephone service.
2) CN/CP should be responsible for a monopoly in public record service to provide:
   (a) Telegram services.

(b) Line switched services (including quasi real-time systems): record services at terminal transmission speeds to 600 bauds (Speeds which can be accommodated economically by telegraph circuits without resorting to a full voice bandwidth).

<u>Note</u>: This would require that the existing TWX, Telex, Data Telex, TelTex and Telegram services be integrated into a single network.

(c) Message switched record services involving store-and-forward techniques and operating at any speed dictated by the current practice and the state of the art.

3) Two-carrier competition is desirable for certain sectors of the Telecommunications market mainly -

(a) Dedicated private line service: voice, digital record, facsimile, telemetering and broadcast network service, audio and video.

(b) Line switched service: digital record in excess of 600 bauds, private voice and facsimile.

(c) Message switched record services for private use.

4) Effective regulation is required which will prevent economic strength derived from protected markets in the monopoly field from being used by carriers to engage in unfair or destructive

practices vis-a-vis other carriers in the competitive field. Regulation must prohibit cross subsidization between various classes of service and in particular between monopoly and competitive services.

5) To avoid wasteful duplication of local services, carriers must be allowed to acquire local distribution facilities from another carrier in order to access a subscriber to their services. Furthermore to prevent monopoly power from denying competitive opportunities in private line services, all carriers must be allowed access to any local (metropolitan) monopolistic switched service.

The problem of examining in isolation specific questions relating to the regulation of private line services and other services which were not regulated prior to August 1, 1970 are immediately apparent.

CN/CP contend monopolistic (public) services require regulatory constraints in the public interest which are not needed for competitive (private) services. On the other hand regulation of competitive services should be broad enough to promote effective competition and yet have sufficient safeguards to maintain fair competition.

In the view of CN/CP it is not useful or constructive to examine the problems relating to private line services without accepting the premise that effective regulation of monopolistic services will and must be different from regulation of competitive services and must preclude cross subsidization between monopolistic and competitive services.

5) REQUIREMENTS OF REGULATION

Regulation of the Telecommunication Industry must protect and promote the availability of Telecommunications Service to meet user requirements and the ability of Carriers to meet these requirements, all consistent with the public good. Regulation must be designed to avoid potential user and carrier problems and to achieve national objectives.

User Requirements

The user is primarily concerned with the availability, cost and performance of services. Specifically the user needs assurance that:

1. Services will be available where and when needed, consistent with his particular requirements, which are designed to minimize (capital and maintenance) costs. This requires that the Carriers take full advantage of technical developments to improve existing services and establish new services.

2. The quality and reliability of service is provided and maintained to the highest degree possible at reasonable cost.

3. Rates charged for service are not unduly or unjustly discriminatory with rates charged elsewhere for similar and other services. Rates should bear relationship to the cost of provisioning over an entire service offering.

4. Rates charged for services do not reflect costs of unreasonable capacity for maintenance, expansion and diversification.

5. An alternate supplier of Telecommunications Services will be available if the quality of service is less than expected.

6. A choice of suppliers will not be limited by artificial barriers between Carriers which preclude competition for Private Line Services. This requires that all Carriers have the right of access to local distribution (loops) and local switching facilities, where supplied by a single Carrier, to extend their Private Line Services.

Carrier Requirements

The carrier is primarily concerned with its ability to provide marketable services at prices which will earn a fair and reasonable return and attract new capital. It must be assured that:

1. Regulation will avoid a competitive advantage being held by one Carrier in the provision of competitive services by reason of an exclusive position in the supply of public services which would prevent other Carriers from sharing in the full market potential.

2. Regulation will prohibit cross subsidization between classes of services and in particular between monopoly and competitive services.

3. Regulation will be sufficiently flexible to permit special rates under certain circumstances. For example, special rates should be recognized for -

   (a) Inter-carrier rentals

   (b) Large single user networks where the user may make a capital contribution towards the provision of service or is prepared to enter into a long term contract.

   (c) Market testing, e.g. provisional rates for new developments.

4. Regulation will not limit earnings to the extent that will affect its ability to -

   (a) Attract new capital.

   (b) Maintain adequate employee training programmes to develop skills required by advanced technology.

   (c) Maintain an adequate salary plan to retain and attract specialists in the face of competition from other industries.

5. Involvement in regulatory processes will be minimized in terms of the assignment of personnel and costs.

6. Regulation will not dilute management's prerogatives for individual company initiative in the decision making process.

National Requirements

Regulation of the Telecommunications Industry must be such that it will promote the provision of services which;

(1) Are responsive to public demands.

(2) Strengthen the national economy and social structure.

(3) Are efficient in the use of radio frequency spectrum.

(4) Do not concentrate economic control.

(5) Provide for national security.

(6) Are responsive to change and developments in national policy.

6. CRITERIA FOR REGULATION

CN/CP regards the existing regulatory tools possessed by the C.T.C. under the recent amendments of the Railway Act as inadequate.

Ultimately as a result of the Telecommission's deliberations, it is expected that a new Telecommunications Act will be passed. It is hoped that the problem of divided jurisdiction in telecommunications matters will be resolved.

It is important that this new Act clearly defines the regulatory powers vested with the authority designated to administer Canadian Telecommunications Policy and the criteria to be used by this authority to judge the reasonableness of tariffs and quality of service provided by Telecommunications Carriers.

The fundamental principles of regulation to be applied to the total industry are examined by CN/CP in their response to Telecommission Study 7(a)(b). This paper (8a) will not deal with regulation of monopoly services nor repeat the detailed developments in 7(a)(b), but will summarize the conclusions in respect to competitive services. It is essential to reiterate the position of CN/CP that regulation must prohibit cross subsidization between various classes of service and in particular between monopoly and competitive services.

CN/CP's submission in response to Telecommission Study 7(a)(b)

recognizes that there are indispensable functions required of an effective regulatory body which apply to the whole spectrum of Telecommunications Services whether competitive or monopolistic.

(1) It must have authority to approve or disapprove applications from non-established carriers to engage in any type of Telecommunications activity in a given area whether as a Telecommunications Carrier or for private use where Parliament has jurisdiction over such activities by virtue of the provisions of the Canadian Constitution. Among other things it must consider whether approval of an additional Telecommunications Carrier is in the public interest. It should be incumbent on the regulatory authority, in the performance of this function, to consult with existing Telecommunications Carriers.

(2) It should have authority to act on customer complaints to ensure that quality of service as defined by the carrier is being provided.

(3) It must have authority to approve or disapprove the use of radio frequency spectrum in accordance with defined criteria. In the case of existing Telecommunications Carriers only technical criteria should apply.

In respect of rate regulation, CN/CP oppose pricing policies based on Company-wide costs. Insofar as it is considered necessary to

regulate rates of competitive services, regulation should be on an individual class-of-service basis.

One of the major undesirable effects of overall rate-base, rate-of-return, regulation is that it permits and often encourages cross subsidization among the various classes of services offered. There are several economic ills that may result from cross subsidization particularly in cases where carriers are supplying monopoly as well as competitive services.

(1) Productive resources of the industry may not be allocated in the most efficient way, e.g. the diversion of capital to meet competition which might be more efficiently used to provide other services.

(2) Cross subsidization can be harmful to competition where a carrier can cut prices below cost, making up the difference from profits earned in other markets, while competitors may have to cover all of their costs in the competitive market. This causes inequitable rates for various classes of service whereby consumers of some services are subsidizing the consumers of other services.

Thus where it is felt necessary to examine and perhaps limit earnings of a Telecommunications Carrier, the regulatory authority should approve or disapprove rates on the basis of separate classes of service.

Under competitive market conditions the danger that high profits can occur and continue is minimal. It is therefore urged that rate regulation of such services should be largely confined to protection against non-compensatory rates harmful to competition or unfairly discriminatory among customers.

Every Telecommunications Carrier should be required to file tariff schedules for all of its service offerings for regulatory review and public information. These schedules should show the charges, areas served and conditions applying to the use of the service. To provide sufficient time for regulatory review and objection by customers or competitors, tariffs with one exception should be filed prior to their effective date according to time periods specified by the regulatory authority. Rate changes in existing tariffs should automatically come into force on the effective date unless disallowed or temporarily suspended for a specified period of time by the regulatory authority on its own initiative or in respect of a challenge. The exception to the foregoing arises when a Carrier must immediately reduce its rates to meet an offering by a competitor under Federal or Provincial jurisdictions.

New tariffs should automatically come into force on the effective date even if under review by the regulatory authority. The regulatory authority should allow cost averageing within an accepted

class-of-service and value-of-service pricing when either pricing technique is not harmful to competition or unjustly discriminatory among customers and when it may promote the development of a service, convenience in pricing, or other favourable result. Cost averaging is the offering of a service at a single price although the costs to provide service to various customers differ. Value-of-service pricing is charging different customers or classes of customers the amount that each is willing to pay.

A carrier should be permitted to offer immediately a competitive service at the rate published previously by a competitive carrier (Federal or Provincial), whether or not that rate is compensatory for the carrier reducing its rate to meet such competition. This means that such competitive tariffs need not be filed before becoming effective. This is a necessary condition to allow more than one supplier of the service. The responsibility for showing that the rate is compensatory, if challenged, lies with the first carrier that published the rate. If the first carrier later raises the rate, other carriers for whom the rate is non-compensatory must do the same.

In general where two major competing carriers exist the carriers should be allowed to confer and discuss rate levels, in the same manner as that permitted Railway Companies under the Railway Act.

The carriers, in cooperation with the regulatory authority, should develop uniform methods of cost accounting and cost separation for purposes of tariff review. A tariff filing for competitive service should require the inclusion of only broad cost information. Upon complaint however, the carrier who first submitted a tariff should have to establish in a complete way the validity of the tariff, as being compensatory or non-discriminatory, according to the nature of the complaint.

As the initiative for the submission of tariffs rests with the carrier, so should the classifications of service offerings contained in the tariffs. As a general rule, carriers should file separate tariffs for distinguishable classes of services in order to facilitate separate consideration and review of each by the regulatory authority. All carriers should have ample opportunity to review all proposals for new service classifications submitted by other carriers and to file at any time objections when a classification is believed to be unfairly harmful to competitition or discriminatory among customers. The regulatory authority should have the final administrative responsibility for working out conflicts among carriers and disallowing inappropriate classifications. The regulatory authority also should be able to undertake reviews of proposed new classifications on its own initiative.

Carriers should be required to file with the regulatory authority copies of all contracts and agreements with other carriers and its customers. These contracts should be considered confidential by the regulatory authority.

The regulatory authority should have the same powers of review and apply the same criteria in the evaluation of contracts as it would if the tariff were public. The regulatory authority should review inter-carrier agreements in order to insure the reasonableness of their terms, particularly when one carrier must rely upon a monopoly service offered by another carrier e.g., the exclusive provision of local loops by telephone-operating companies.

PART TWO

REPORT OF THE

TRANS-CANADA TELEPHONE SYSTEM

STUDY 8A: PROBLEMS RELATING TO THE REGULATION OF PRIVATE WIRE SERVICES

A. INTRODUCTION

This study will analyze problems relating to the regulation of certain Canadian telecommunication services. These services will be referred to as "private services" and defined as follows:

> Private services include all telecommunications services other than public telephone and message telegraph service. They are generally characterized by having more than one supplier and varying degrees of competition.

A brief description of the services, their development, the size of the market, and the present regulatory situation is included. The main body of this report will discuss some of the problems identified by users and suppliers of private services. The results of this analysis should assist in formulating policies appropriate for the development of private services in Canada.

B. BACKGROUND

1. Examples of Private Services Offered by the Telephone Companies

   a) Private-Line Voice[1], Teletype

      - provides facilities which carry voice or printed messages respectively. There is no access to the public telephone network.

   b) Teletypewriter Exchange Service (TWX)

      - provides switched teletype communication between terminals via the facilities of the public telephone network.

[1] Private-line voice is considered as public telephone service by the telephone companies and regulatory bodies in Nova Scotia and Prince Edward Island. As such, it does not qualify under the definition of private services in those areas.

c) Program Transmission - Video, Audio

- provides dedicated facilities for carrying audio and video signals for television, radio and similar uses.

d) Data Transmission - with and without terminal equipment

- provides the capability of sending and receiving data through either the facilities of the public telephone or dedicated private line networks.

e) Private Mobile Radiotelephone Systems

- provide the equipment and facilities necessary for internal communications between vehicles and specific locations.

f) Miscellaneous Services

- These include special purpose private communication systems and/or terminal equipment.

2. Market Development

Some private services have been long standing offerings of the telephone companies. However, since World War II, and particularly in the last decade, the supply of private services has become an increasingly important segment of Telco-supplied services. During the same period, other organizations entered the market in competition with the telephone companies. The Canadian National and Canadian Pacific Railways operate a communications network which is used both for internal requirements and to supply public message telegraph and private services. Other companies offer a variety of equipment for data, radiopaging, private mobile radiotelephone, and other services. In addition, many user-owned or leased communications systems serve purposes which could otherwise be satisfied by the private services of the common carriers.[2] Private services have thus developed in a competitive environment. There has been little direct regulatory involvement.

[2] See Study 8b (i)

The data compiled on the following pages are intended to show the general relationship between private services and public telephone services. Three measurements have been used to estimate this relationship - circuit miles, revenues, and circuits by major Trans-Canada cross sections.

Table 1 shows, for the Trans-Canada Telephone System, the circuit miles used for long distance message service (including TWX) and those used for inter-city private line services respectively. Table 2 shows the relationship between revenues from private services (local and inter-city) and the total operating revenues of all TCTS members. Table 3 shows the number of message toll and private line circuits in selected cross sections. All data are for the years 1967-8-9. Growth rates have been included in Tables 1 and 2.

It should be noted that the principal users of extra-Provincial private services are the Federal Government (notably DND) and the national radio and television broadcast agencies. These customers account for over one-half of these private service facilities.

TABLE 1: CIRCUIT MILES - TRANS-CANADA TELEPHONE SYSTEM - INTER-PROVINCIAL ONLY

See Note Below

	1967		1968		1969	
	Miles	% of Total	Miles	% of Total	Miles	% of Total
Message Toll (incl) TWX	4,730,000	90%	5,560,000	86%	7,020,000	86%
Private Line	506,000	10%	907,000	14%	1,125,000	14%
Totals	5,236,000		6,467,000		8,145,000	
Growth in:	1967 - 1968	(%)	1968 - 1969	(%)		
Message Toll	17%		26%			
Private Line	79% *		24%			
Totals	24%		26%			

TABLE 2: ORIGINATED REVENUES - TRANS-CANADA TELEPHONE SYSTEM

See Note Below

Year	Private Services (including intra-provincial business)	Toll Operating Revenue TCTS Member Companies	% Private Services
1967	$ 45,118,000	$ 1,046,832,000	4.30%
1968	$ 51,797,000	$ 1,138,394,000	4.55%
1969	$ 58,341,000	$ 1,268,277,000	4.60%
Growth 1967-1968	15%	9%	
Growth 1968-1969	13%	11%	

NOTE: Telephone records do not distinguish between exchange-connected circuits (Foreign Exchange and Tie Trunks) and non-exchange connected voice grade private lines. The former were extracted by an estimating process based on current available data.

* Due to a significant increase in defence requirements.

TABLE 3 MESSAGE TOLL AND PRIVATE LINE CIRCUITS (1)

TRANS-CANADA TELEPHONE SYSTEM MAJOR ROUTES

See Note Below

INTER-PROVINCIAL

	B.C. TO ALTA	% OF TOTAL	ALTA TO SASK	& OF TOTAL	SASK TO MAN	% OF TOTAL	MAN TO ONT	% OF TOTAL	ONT TO QUE	% OF TOTAL	QUE TO N.B.	% OF TOTAL	N.B. TO N.S.	% OF TOTAL
1967														
Message Toll & TWX	355	93	565	95	530	94	499	92	964	77	372	93	322	80
(2) P/L Voice & TTY	4	1	3	1	3	1	3	1	150	12	4	1	6	2
Program	24	6	26	4	28	5	30	5	34	3	20	5	25	6
Defence	–	–	–	–	–	–	14	2	100	8	3	1	47	12
Total Voice Equivalent	383	100	594	100	561	100	546	100	1248	100	399	100	400	100
Total 1-way Video	4		5		4		4		4		4		3	
1968														
Message Toll & TWX	433	92	686	94	631	94	630	90	1238	79	422	87	372	82
(2) P/L Voice & TTY	4	1	4	1	4	1	5	1	167	11	6	1	8	2
Program	24	5	26	4	28	4	30	4	34	2	20	4	25	5
Defence	9	2	10	1	10	1	35	5	121	8	34	8	49	11
Total Voice Equivalent	470	100	726	100	673	100	700	100	1560	100	482	100	454	100
Total 1-way Video	4		5		4		4		4		4		3	
1969														
Message Toll & TWX	517	92	797	94	770	94	791	90	1484	71	486	80	441	84
(2) P/L Voice & TTY	5	1	6	1	7	1	8	1	179	9	5	1	8	2
Program	24	4	26	3	28	3	36	4	34	2	20	3	24	5
Defence	18	3	21	2	17	2	48	5	384	18	98	16	49	9
Total Voice Equivalent	564	100	848	100	822	100	883	100	2081	100	609	100	522	100
Total 1-way Video	4		5		4		4		4		4		3	

CANADA - U.S.A.

	B.C. TO USA	% OF TOTAL	ALTA TO USA	% OF TOTAL	SASK TO USA	% OF TOTAL	MAN TO USA	% OF TOTAL	ONT TO USA	% OF TOTAL	QUE TO USA	% OF TOTAL	N.B. TO USA	% OF TOTAL
1967														
Message Toll & TWX	258	93	53	48	–	–	166	93	987	86	1083	92	102	39
(2) P/L Voice & TTY	9	3	1	1	–	–	3	2	144	11	73	5	5	2
Program	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Defence	11	4	57	51	–	–	9	5	40	3	42	3	157	59
Total Voice Equivalent	278	100	111	100	–	–	178	100	1171	100	1198	100	264	100
Total 1-way Video	–		–		–		–		4		–		–	
1968														
Message Toll & TWX	322	57	71	48	–	–	245	79	1190	77	1157	83	100	29
(2) P/L Voice & TTY	9	2	1	1	–	–	3	2	160	9	79	4	5	2
Program	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Defence	236	41	75	51	–	–	59	19	214	14	184	13	238	69
Total Voice Equivalent	567	100	147	100	–	–	307	100	1564	100	1420	100	343	100
Total 1-way Video	–		–		–		–		4		–		–	
1969														
Message Toll & TWX	357	62	107	34	–	–	263	79	1562	80	1187	75	111	47
(2) P/L Voice & TTY	13	2	2	1	–	–	8	2	178	8	87	3	6	3
Program	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Defence	206	36	203	65	86	100	60	19	222	12	348	22	120	50
Total Voice Equivalent	576	100	312	100	86	100	331	100	1962	100	1622	100	237	100
Total 1-way Video	–		–		–		–		4		–		–	

(1) Does not include circuits leased to other carriers.
(2) These figures represent the voice equivalent for teletype circuits.

NOTE: Records for Private Line Voice and Teletype exclusive of Foreign Exchange, Tie Trunks, and Off-Premise Extensions were available for 1969 only. Using this current data as a basis, appropriate statistics were developed for 1967 and 1968.

3. Canadian Regulatory Situation Today

a) General

In general, private services have been free from direct regulation. Although there is no clear distinction between private services and other telecommunication services in most provinces, the provincial regulatory agencies appear to have the legislative power to impose direct controls. The Federal Government has recently amended the Railway Act to "remove the exemption (from Railway Act) for private wire services."[3] Actual regulatory practice is consistent in both Federal and Provincial jurisdictions with only a few exceptions. These practices and exceptions are outlined below.

b) Rate of Return

Both Federal and Provincial regulatory bodies examine the overall rate of return on telephone company operations. This affects the rates which are set for private services, since the revenues derived from private services contribute to the total revenues of the telephone companies. In addition, investments in private services are included in the capital structure on which the rate of return is calculated.

c) Approvals for Specific Rates

The only provincial regulatory agencies which approve rates for all intra-provincial private services supplied by companies under their jurisdiction are the Public Service Board of Quebec and the Board of Commissioners of Public Utilities for Newfoundland and Labrador. The regulatory authorities in Nova Scotia and Prince Edward Island approve rates for private-line voice service.

[3]Bill C11, House of Commons of Canada, 1969.

d) Approvals of Construction Expenditures

In most provinces, investment management and the decisions to undertake new private service projects are left to the discretion of the telephone companies. However, in Nova Scotia, all projects over $5,000 must receive prior approval; while in Saskatchewan[4] and Newfoundland, those involving capital expenditures in excess of $25,000 require approval.

e) Cost Separations

The fact that private services should not place a burden on public telephone service has been accepted throughout the industry. However, until recently, little attention has been directed at the separation of costs between classes of service by the Canadian regulatory bodies. Both the Commissions and the industry appear to recognize the problem of identifying specific costs when several services use the same facilities and labor.

At the present time, Bell Canada, the New Brunswick Telephone Company and the Newfoundland Telephone Company - at the request of their regulatory bodies - are conducting research into the feasibility of cost separation. The problems of identifying costs are discussed further in Section D(1).

[4]While the other TCTS members are subject to the authority of a designated regulatory commission, Saskatchewan Telecommunications is controlled by its Board of Directors, the Chairman of which is the Minister of Telephones for the Provincial Government. Approvals for projects over $25,000 are given either by the Board of Directors or the Cabinet at the discretion of the Minister.

C. ANALYSIS OF THE EXISTING ENVIRONMENT

1. General

Many of the basic problems relating to the regulation of private services result from the varying characteristics of the markets in which the services are supplied. We understand that a more detailed analysis of supply conditions - monopoly, oligopoly, and competition - will be contained in Telecommission Study 2(a). Some demand characteristics are covered in Study 2(e).

Different supply conditions apply to different segments of the private service market. The provision of intercity transmission facilities, for example, would be described as oligopolistic - a small number of suppliers each with a substantial share of the market. Local distribution facilities, on the other hand, are supplied almost exclusively by the telephone companies. The demands for other private services (e.g., terminal equipment) are met by many suppliers.

The effects of an oligopoly on pricing policies, innovation and entry into the market are not clear. In theory, the users of these private services might argue that the common carriers are in a position to restrict the entry of new competitors; that they have the power to control prices; that their secure market position reduces the incentive to improve technology, quality and efficiency; and, that some form of regulation is required. However, an oligopolistic supply condition such as applies to the provision of inter-city private services has advantages. These include many of the benefits of competition and reasonably efficient use of resources.

That segment of the market which is more clearly competitive requires only the self-regulating features of supply and demand and the rules governing the conduct of business in general. The provision of some types of terminal equipment has many of the characteristics of this type of market. As a result, the need for regulation in this area cannot be justified.

The analysis in the next few pages will be directed primarily at the provision of inter-city facilities for private services. References to terminal equipment will be made as required.

2. Limited Competition

Limiting the number of common carriers providing inter-city transmission facilities for private services can be advantageous for Canadian telecommunications users. Inter-city private services, like the long distance "public services" of the common carriers, are supplied by transmission systems which are characterized by decreasing unit costs. To the extent that competitors duplicate facilities, each company's economies of scale are not realized and overall costs are higher.

According to one economist:

> The optimum scale of plant may be large enough in comparison with the market...so that there is not room in the industry for enough firms to make the market one of pure competition. If the firms of the market were broken up...each may have a smaller than optimum scale of plant. Consequently, ...the market prices of the product may be higher with such an arrangement than they would be with an oligopolistic market structure.[5]

[5]Leftwich, Richard H., The Price System and Resource Allocation, Holt, Rinehart and Winston, 1966, P.239.

In the past, the demand for private services has been small in relation to that for other telecommunication services. As a result, private services have generally been supplied by expanding the communications facilities already in existence. The market for inter-city services has, therefore, attracted only two direct competitors in the common carrier field - the national railways and the telephone companies.

In addition to the effects of competition on the attainment of economies of scale (low supply costs), unrestricted freedom of entry would attract new competitors only to the most profitable regions, leaving the other areas to the common carriers. In such a case, adjustments to pricing patterns would be required, which would probably result in higher prices for users in these other areas. The effects that this would have on achieving the optimum development of communications in Canada cannot be predicted at this time.

Regional and national communications policy, developed mutually by the active participation of the carriers and government, can assist the planning of private services development. The management of the affairs of the carriers, within the framework of the established policy, should be the exclusive responsibility of these carriers. If the goal is to supply inter-city private services throughout Canada, while retaining some benefits of competition, then the present environment of a limited number of suppliers is satisfactory.

3. Technology and Innovation

The growth of public and private services has been accompanied by the application of new technology and innovation. This growth could

not have been achieved without the desire of the common carriers to adopt new methods of communication and their willingness to assume the risks involved. Construction of the Trans-Canada Telephone System's microwave network, the subsequent progress in increasing its capacity and capability, and the development of electronic switching are examples of the application of new technology.

As a result of industry research and development activity, communications technology has advanced at a rapid pace. New techniques and equipment are adopted as quickly as possible subject to certain economic constraints. A significant factor governing the speed at which these new developments can be introduced on a large scale is the cost of displacing existing plant. Because of the high cost of communications equipment and facilities, these economic considerations are of prime concern to the user who desires communications at the lowest possible rates and also to the telephone companies who have a responsibility to ensure the economic viability of their operation.

The competition provided by the existing market structure for private services has contributed to the development of new service offerings. However, the corresponding technical developments needed to meet these market requirements have largely been the result of research and development associated with public telephone service.

Regional and national policy, developed mutually by government and industry, would be beneficial in providing the telephone companies with economic and social guidelines around which research and development could be planned.

4. Pricing

Although pricing of telecommunication services will be discussed in greater detail in Telecommission Study 7(ab), some facets deserve mention in this paper.

The possibility of subsidization of private services with revenues from public telephone service is an understandable concern not only to telephone users but also to competitors in the private service market. The implications are, of course, that telephone users might be helping to pay for private services and that the subsidy might give the telephone companies an unfair competitive advantage.

It is worth noting that the opinions of users and competitors are different. For example, some users of private services have maintained that the rates for their private services are too high. Competitors, on the other hand, have voiced the opposite argument - prices are too low and are being subsidized by monopoly service revenues.

The telephone companies firmly believe that their participation in both monopoly and private services markets results in lower prices and better service to all telecommunications users.

D. PROBLEMS OF REGULATING PRIVATE SERVICES

1. Regulation of Rates

Regulation of rates reduces the ability of suppliers to react quickly to changes in market conditions. The inflexibility of tariffs and the associated administrative procedures could reduce many of the benefits which might otherwise be derived from competition. We believe that it is desirable to allow freedom and flexibility in setting rates, so that the benefits of competition can be realized.

Rate regulation does not lend itself readily to the meeting of special customer needs. At the present time, many "custom tailored" private services are rated on an individual "special assembly" basis. If tariffs were required for every private service of this kind, the administrative process would be complex and the benefits doubtful. On the other hand, if customer needs were made to conform to a limited number of tariff offerings, then some specialized requirements could not be satisfied.

In addition to the previous problems, there is a further difficulty in establishing a basis for determining satisfactory rates and for identifying cross subsidization and illegal price discrimination. Rates are influenced variously by competition, value of service, and costs. The use of costs as the primary basis for regulatory decisions is at best a highly arbitrary procedure.

That is not to say that cost determination does not have some useful purpose but rather to emphasize the attendant problems and the limited usefulness of such a process in setting prices for individual services.

The determination of the costs of a specific product that shares common production facilities introduces some serious practical limitations. Exact costs cannot be completely determined for any one service. Studies by the U.S. Telecommunications Industry illustrate the problems of cost separations. Each time a study is undertaken, a different cost separation technique emerges. The feasibility of separations is currently under investigation in Canada.

2. Approval of Private Service Undertakings

Regulation of expenditures for private service undertakings is subject to many of the same criticisms discussed above. Market demand is the best indicator of the desirability of new investments in private services. Because of this, and the fact that investment decisions are vital to the economic viability of the companies concerned, control of capital expenditures should remain a management responsibility. Regulation of expenditures transfers this essential function to the regulator. Furthermore, it does not provide an effective substitute.

The security of information in competitive situations is jeopardized when details of new undertakings are made public through regulatory procedure.

3. Regulation of a Competitive Market

Although the common carriers are the major competitors in the provision of private services at the present time, there are other suppliers active in specific segments of the market. Private mobile radiotelephone service, Radio-Paging and the supply of data terminal equipment are examples of such private services.

Regulation in these latter markets reduces unnecessarily the benefits of competition. It also becomes less effective and more complex as the number of regulated competitors increase. Therefore, we believe regulation to be unnecessary in such cases.

4. Regulation Jurisdiction

The constitutional aspects of Federal versus Provincial regulatory jurisdiction are being examined in more detail in Telecommission Study 1(a).

The problems of multiple regulation are clearly evident in the United States. Recognition of these and the importance of taking action to avoid their repetition in Canada is essential.

While these problems are not specifically confined to private services, there are certain aspects which have special meaning due to the competitive nature of these services. Consider, for example, the position of those carriers who, while subject to Federal regulation, must compete for intra-provincial services with carriers who are subject to provincial regulation. These and similar jurisdictional problems will require much study by both federal and provincial agencies as well as the common carriers.

E. SUMMARY

The following statements summarize the views of Trans-Canada Telephone System members concerning problems relating to the regulation of private services:

1. The minimum amount of regulation required to achieve regional and national objectives will provide the general control best suited to Canadian needs. Such regulation should avoid the problems created by dual regulation.

2. Most private services in Canada have been supplied in an oligopolistic setting with few regulatory controls. We believe that this arrangement, which has generally met customer needs and benefitted telecommunication users, should continue.

3. A commitment to free competition for some private services eliminates the need for regulation. The provision of customer terminal apparatus is an example of this type of service. We believe this situation should continue without rate regulation.

PART THREE

REPORT OF THE

"IN-HOUSE" PROJECT TEAM

CHAPTER I

Introduction

Purpose of the Study

In September 1969, the Minister of Communications authorized an extensive study program to examine Canada's telecommunications industry. This "Telecommission" has organized some 50 studies to explore many of the legal, economic, technological and environmental aspects of telecommunications in Canada.

This Study is one of several in Section 8 and it has, as its primary purpose, the objective of identifying and examining the problem areas surrounding the regulation of private line services supplied by the telecommunications carriers.

Background of the Study

Canadian telecommunication companies were originally chartered by the federal and provincial authorities to provide telephone and telegraph services to the public. These services, which form the basis of the public telecommunications system, have been traditionally viewed as a natural monopoly and the exercise of the franchise has been accompanied by various degrees of regulation to protect the public interest.

In addition to the need for public telephone and telegraph services, there has always been the need for certain private telecommunication services. These are primarily of a commercial nature and they are often leased to individuals, businesses, or governments on a contractual basis. These private line services were originally dedicated wire lines leased to such customers as newspapers and stockbrokers for direct voice or telegraphic communications. However, in recent years the volume and variety of private line services has been expanding at a very rapid rate. Today these services include teletypewriter exchange, program transmission for radio and television and data transmission to name only a few.

There has been, therefore, a traditional distinction between public and private line services. It is interesting to note, for example, that in its first annual report in 1880, the Bell Telephone Company of Canada reported Private Line rentals to be \$5,023.01.[1]

1 R.C. Fetherstonhaugh. Charles Fleetford Sise 1834-1918. Montreal Gazette Printing Company Limited, 1944, p. 186.

In general, the development of many of the private line services has taken place in a competitive environment and, in some regulatory jurisdictions in Canada, they are outside the direct purview of the regulatory authority. Therefore, as well as the distinction between public services and private line services there has often been a parallel distinction between regulated and unregulated services.

There is a close interrelationship between a telecommunication carrier's public and private line services. The services are often provided over common facilities and some of the private line services tend to become indistinguishable from public services. Consequently, it is difficult to formulate a precise definition which would permit careful examination of the issues. However, regardless of the definition, the distinction that has existed between the two types of services, and the related dichotomy between regulated and nonregulated services in some jurisdictions, have led to a variety of issues concerning the regulatory environment for private line services.

Scope and Limitations of the Study

The examination of the issues and problems surrounding the regulation of private line services could easily lead into a study of considerable proportion. The broad issues of competition versus monopoly; the legislation and regulatory approaches of other countries; and, the role of regulatory bodies are subjects which could be considered relevant to this study. The project team has recognized, however, that these subjects are the focus of other Telecommission Studies. Therefore, the scope of this study has been carefully chosen to examine private line services and specific issues relating to their regulation. It has avoided a broad excursion into the other areas.

In line with this position the following terms of reference were adopted for the study:

1) A definition of the scope of the study and review of some of the "private line" services offered by the carriers and an overview of relevant financial and commercial characteristics.

2) Reference to private line technology, present and future, with a view to identifying its relationship to the study.

3) A description of the regulatory situation relative to private line services in Canada.

4) An identification of problem areas faced by both the users and suppliers of private line services.

5) A presentation of some of the basic regulatory alternatives with respect to private line services, and a discussion of how these would contribute to the solution of problem areas. (i.e. a definition of the various possible objectives of regulation).

6) A presentation of points of view that favor, or do not favor, regulation of private line services. This will serve to identify potential problems and benefits arising from regulation.

7) An analysis of the problems and regulatory alternatives relative to private line services.

Relationship to other Reports

The inquiry into the problems relating to the regulation of private line services has been undertaken by project teams which represent both the telecommunications carriers and government organizations. This study is being undertaken by an "In-House" project team comprised of representatives from government departments, government agencies and regulatory commissions. Parallel studies are being carried out by representatives of CN/CP Telecommunications and the Trans-Canada Telephone System.

All the study groups have used the same terms of reference as their general guide for the study; therefore, it is anticipated that there may be some overlap in the factual background contained in the three reports. During the course of the studies the necessary research was discussed by the Liaison Officers for the three study groups and an effort was made to share data where possible.

Project Team

The "In-House" project team is comprised of representatives from government departments and agencies. They are:

Mr. E.R. Bushfield	-	Department of Communications
Mr. A.B. Donaldson	-	Department of Communications
Mr. J. Hanley	-	Canadian Transport Commission

Mr. K.T. Hepburn - Department of Communications

Mr. R.E. Santo - Canadian Broadcasting Corporation

Mr. R. Thérrien - Canadian Radio Television Commission

Although these members of the team contributed to the report and participated in its preparation and review, they do not necessarily agree to every statement made in it.

Organization of the Report

This introductory chapter has stated the purpose and scope of the study and has presented a brief background for the subject area. Chapter 2 is directed toward the presentation of the concepts of private line services and information which will provide an appreciation of the significance of private line services of the telecommunications carriers. Chapter 3 surveys the current regulatory setting at both the provincial and federal levels. Chapter 4 is directed to an examination of the problem areas that could possibly be attributed to the regulatory environment for private line services. It also attempts to establish some of the basic regulatory alternatives that are available with respect to these services. In the final chapter the project team has presented a summary and discussion of the major points that emerged during the study.

CHAPTER II

Private Line Services

The Concept of Private Line Services

Historical Background. The terms "Private Wire" and "Private Line" have been associated with the communication industry almost from its birth. Originally telegraph and voice communications utilized technology that required a single wire between two communication instruments and an earth return to complete the circuit. As the public networks developed, switchboards became more complex and the improved transmission standards required a second wire to extend the distance from the switching point at which a subscriber could be located. However, needs existed at that time, as they do today, for point-to-point communications on a continuing basis between separate locations such as a downtown office and a warehouse, or between two company offices in separate cities.

Over the years, as communications developed and networks became more extensive, the needs for point-to-point communications also expanded, but not at the same rate. Expansion of commercial organizations to multi-plant operations in locations across the country, maintained continuous pressure for the development of communications services that would carry a substantial volume of traffic between predetermined locations.

Initially, there were substantial savings to be realized in not having communication services interconnect with the manually operated switchboards or, later, with the mechanized switching systems that were required to serve the burgeoning growth of random communications traffic. Some of these savings were passed on to the users, since there were mutual benefits involved. From the users' point of view, the services were available to him as required, and leasing them on a monthly basis made his communication costs more controllable.

In the telegraph field, users could lease private line facilities for particular portions of a day throughout the monthly period. For instance, brokers and newspapers realized certain advantages with services that could be leased 4 hours, 8 hours or 24 hours per day. In these cases, the costs of service to users bore some relationship to its value.

Private line service users have been able to experiment to some degree with various kinds of telecommunications equipment, which was later standardized by the carriers for broader applications. The Telex and TWX networks grew out of the expanding use of teletype equipment on a private line basis. At the present time broadband service, i.e.service involving transmission over facilities whose bandwidth exceeds that of a single voice channel, is being developed under

private line circumstances. Similarly, the integration of radio circuits into the public voice network occurred after a number of applications on a private line system had been tried. However, private line services cannot be considered a prime source of trends in the development of the public switched network.

From a regulatory point of view, private line services have not generally attracted much attention, since the services were usually established on a contractual basis between consenting parties. It has only been during the past few years that private line systems have grown in size and scope to a point that increasing consideration has been given to them, usually to ensure that the rates appropriately reflect the costs of providing them.

As may be seen in the following section, the meaning of the term "private line services" is becoming less clear from the point of view of the user, supplier and even the regulator.

Current Concepts of Private Line Services. At this point in time the term "private line service" is applied to services that range from the simple point-to-point telephone facility terminated by two telephone sets, to complex international networks such as those used by General Motors, employing electronic switching and dedicated circuits terminating in many points in Canada and the United States. The term also applies to the broadband cable or microwave channels used by a broadcaster to serve a network or family of TV stations, as well as studio-transmitter facilities; it can include the communication facilities linking a dispatcher with a private land mobile radio transmitter used to communicate with a fleet of vehicles; it can also refer to a facility that connects an exchange telephone number in one city, which can be accessed by any telephone subscriber in that city, to the premises of the user in another city.

Thus, the term "private line service" refers to a whole family of communication services which serve the non-network needs of the user. These needs are often much less random than the normal telephone traffic. Consequently, such traffic patterns can be more accurately forecast and have less requirement for the hierarchical switching system that serves the public network carrying the random traffic.

In order to fully appreciate the possible regulatory problems that might be associated with private line services, it was necessary to consider some of the various concepts for these services. A number of approaches to defining private line services were identified during the study. These have been presented and commented upon below.

(1) "Private line services are those communication services which are not subject to regulation".

There is nothing conceptual about this definition and it is extremely vulnerable to changes in legislation, some of which have occurred during the preparation of this report.

(2) "The term 'private line services' should be avoided and the services described, more appropriately, according to their function".

The proliferation of uses and the variations involved would soon make such a categorization impossible.

(3) "Private line services are those telecommunication services which are provided to a customer by means of facilities that are exclusively dedicated, for any period of time, to serve his telecommunication requirements".

This definition is too general and conflicts with the growing requirement for shared use of private line facilities among users who have common needs that are not met by use of the public network. A case in point is data-transmission requirements. In the higher speed ranges (over 2400 bits per second) switched communication networks are being provided by carriers as private line services even though they are available to any number of users on a time-shared basis and are billed on an 'as used' basis.

(4) "Private line services are those telecommunication services which are provided to a customer by means of facilities that are exclusively dedicated, for any period of time, to serve his telecommunication requirements, and which are not interconnected to the system by which the carrier provides services to its customers generally".

This definition, while similar to (3) above, makes the significant distinction that private line services are not network connected. It appears that this definition has closely approximated the realities of

private line services in the past; however, its viability seems to have been eroded by developments in the industry. Private Line Exchange services, mentioned above, and the introduction of package private line offerings that include exchange connected services are examples of the type of development that has contributed to this erosion.

(5) "Private Line Services are a rating concept."

This approach sets aside the technology involved in providing the services, and considers the traffic generated by the user. The basic assumption of this definition is that a carrier can realize savings if a user can guarantee and contract for telecommunication time between predetermined or preselected points. Among other things, this removes the need to apply the forecasting techniques used in planning the public network, which are based on a statistical analysis of random traffic to determine the probability of such traffic occurring on certain routes, and in what quantity and timeframe.

As long as a supplier can show that he can realize certain economies when the user provides such forecasts of traffic patterns, then private line services may be defined as a rating concept designed to recognize such economies and reflect them in appropriate rates to the user. On the other hand, if these needs can only be served by more expensive custom-designed services, it is expected that the associated rates to those using the private line services would reflect the higher costs involved.

(6) "Private Line Services are a family of services which provide guaranteed quantities of information capacity, to a user between any number of specified points of his choosing and at times of his choosing."

This definition avoids much of the specificity in the other concepts; consequently, it has the advantage of minimizing the number of conceivable exceptions. It also provides for the idea that the rates for these services could reflect economies of scale when available, or premium charges as appropriate.

It would, of course, be desirable to arrive at a single definition for private line services, however, it was recognized that many of the characteristics of private line services implicit in the various concepts were worthy of note. Therefore, they have been presented here and no specific definition has been selected for this report.

Scope of Private Line Services

Most telecommunications carriers in Canada provide a range of private line services that vary both in price and in scope of service. Any detailed examination of the variations in scope would be a travelogue through the imaginative ingenuity that users have employed in fitting private line service offerings to their communication needs. This would then have to be balanced against the measure of success that the communication suppliers have enjoyed in creating terminology to fit new uses and allocating an appropriate rate to charge for the service.

Technically, the private line services available from carriers are limited only by:

(1) The performance characteristics of the facility providing the private line service;

(2) The availability of suitable interfacing equipment to terminate the facility.

With respect to (1) the maintenance of circuits used to provide private line service varies widely between communication companies and also within the network of any particular supplier. Private line circuitry used to serve voice needs will, on an "as found" basis, pass voice traffic with quality that ranges from acceptable to very clear. The same channels may not be suitable for digital data at speeds of over 300 bauds with an acceptable error performance. However, most carriers will do their best to either select or condition such circuits to pass information at speeds up to 2000 bauds at little or no expense to the user. Speeds beyond this limit can only be achieved with special conditioning and maintenance and the installation of equipment for which appropriate charges are applied.

The most important factors affecting the scope of private line use are the policies of the individual communication suppliers and their associated rating structures. Of these, the rating structure is particularly complex and requires considerable experience on the part of the user to ensure that he is getting the best value for his expenditures.

Consider, for example, a private line between two points to provide voice transmission. If the two points are 50 miles apart, most telephone companies in Canada will provide the service at a line cost of $4.00 per mile per month, together with appropriate terminal charges. However, if more than one circuit is required, some carriers will provide a "price break" for quantities of 12, 24, 60 and 120 circuits, whereas other companies will not. This pricing arrangement, known as Telpak, results in a line rate of slightly over $2.00 per circuit per mile for groups of 12 circuits, diminishing to a line rate of .58¢ per circuit per mile per month if 120 circuits are required. Coupled with this rate, of course, is a limitation on the number of locations where such Packs may be terminated Thus, such rating arrangements are usually available only between larger centres of population.

To the above is added a "declining line rate with mileage" rating approach. All the telephone companies participating in the Trans-Canada Telephone System will provide a single voice-circuit that reduces from approximately $4.00 per mile per month at a 50 mile distance to approximately $1.00 per mile per month if the distance is in excess of 3000 miles. Thus, beyond a certain distance, circuits are more economically purchased on an individual basis than in groups of 12 or 24.

The scope of voice private line service is relatively easy to define, though it has a complex rating structure associated with it. In the data transmission field, however, both the CN/CP Telecommunications and the Trans-Canada Telephone System provide a switched broadband private line system that can be shared by users On these systems it is not possible to transfer traffic between users, a factor which preserves the definition of private line for purposes of deriving rates. Since data transmission may be more precisely defined and categorized than voice or analog transmission, the rating structure is much less complicated and results in a declining rate per bit with increased speed of transmission. Though the switched data systems are relatively new, an attempt is being made to provide private line service coincident with the needs of the user.

Following is a short list of some of the major and most frequently used private line services available today:

- Private Line Voice Service: This is described above.

- Private Line Teletype: This service is similar to private line voice, with the exception that the input and output terminals are teletype machines or equivalent; because of its lower bandwidth requirement this service is offered at a lower rate.

Program Transmission Channels: These are used in the broadcasting industry for audio and/or video transmission, usually between studio and transmitter locations or for intercity services of a particular nature.

Data Transmission Services: As mentioned above, these include a very large range of communication facilities to handle varying data transmission requirements; though generally rated on a basis of increasing dollars per unit of distance with increasing bandwidths, some consideration is being given to rating principles that involve time, speed and distance on a per message basis.

Relationship of Private Line Services with Technology

There are two ways of viewing the relationship of private line services with technology. On one hand, it is possible to place the emphasis on the value of service and ignore the technology that is used to provide it. This viewpoint may be particularly relevant to the fact that any given private line service may use a whole range of communication facilities: terrestrial microwave systems, communication satellites, and buried coaxial cable. On the other hand, technology cannot be ignored completely, since it is fundamental to the cost of providing the service and the rates that are charged for it. Therefore, although there is no emphasis in this study on the technology related to private line services, there are some considerations that deserve comment.

It is possible to state that many of the private line services used now, and in the foreseeable future, can be served by the same technology used by the systems serving the public network. However, the growth in the use of private line services has not been coincident with the growth of regular network services. Thus, when improved technical efficiency was required to serve the public network through the use of microwave links, for instance, a similar need was not immediately reflected by the smaller number of private line voice services. Thus, it has been quite feasible to prolong the life of certain fully depreciated cable routes that have low maintenance costs but are unsuitable for network service, by using them to handle private line services. Direct costs in these cases would be difficult to deal with. Such use would apply particularly to private lines of less than 300 miles in length.

Another factor is the contribution that guaranteed traffic capacity makes to the planners of telephone company systems. Private line requirements, particularly as they increase in quantity, can be given circuit assignments in transmission carrier systems to fill up "gaps" around the circuits assigned in patterns for network switching purposes, and often resulted in more efficient performance of the carrier system.

Though only a modest case can be made for considering the impact of technology in the regulation of private line services, it would be unrealistic to ignore it completely. It is possible that in the future, when much greater use is made of the more expensive broadband facilities for private line services, the net impact will be significant.

Satellite Technology. The impact of satellite technology and a domestic communications-satellite system on private-line usage is speculative. There appears to be some potential for Economy, as compared with augmenting terrestrial systems for communications between widely separated points in sparsely populated areas, such as the far north. The regulatory processes under these circumstances will require communications policy objectives in order to deal with the associated allocation of costs and the derivation of rates.

Significance of Private Line Services

Any regulatory issues arising from the provision and use of private line services must first be considered in the context of their significance to the total telecommunications spectrum. There are no easy, clear-cut means of determining the importance of private line services in total, since the variety of the services involved, and the conditions under which they are provided, differ significantly among the telecommunications carriers in Canada. In addition, there is the influence of the communication systems in the U.S. interacting with users in Canada through corporate communication links which usually reflect different regulatory practices.

It does seem clear, however, that when used as a rating concept by the carriers - the significance of private line services will be whatever they wish to make it.

Historically, the growth of telecommunications in Canada has been served by the vast public networks established by the telecommunications industry. However, as pointed out earlier, there has always been a requirement for predictable point-to-point traffic which has been satisfied by what appear to be lower cost facilities - from the point of view of the users. The growth in the private services market has been particularly sensitive to rates. The market was primarily that small segment of the total telecommunications market that was better handled by some alternative to the public network.

For instance, as late as 1962 and 1963, the Trans-Canada Telephone System had very few long haul circuits extending across the country. With the exception of special requirements such as national defence and radio and television services, the majority of long private lines were used for purposes other than voice, such as teletype. Thus, railway communications organizations provided the majority of the longer private line circuits. At the same time, "short private line services", extending up to 500 and 700 miles in length, were more heavily oriented to voice communications, and the majority of this market was served by the telephone industry. One significant reason for this condition was that voice communications beyond 700 or 800 miles received very few "price breaks". The only one in existence at that time was Wide Area Telephone Service (WATS). As late as 1966 it was cheaper to subscribe to a WATS circuit, which is provided on the public network, for voice communications from Toronto, Montreal or Ottawa to Regina or points further west, than it was to use private line voice circuits. As a result, users would contract for WATS circuits to reach western points, terminate them on their switchboards, and, if necessary, dial them up in the morning and operate them all day as a private line. This type of use tended to increase switching costs and, to offset the trend, the TCTS introduced a rate for private line voice that declined with mileage.

This illustration is used only to indicate that the growth of the private line market will depend significantly on the inability of the public network to handle changing needs. However, within the private line market certain competitive forces are in action, and there is a trend towards introducing decreasing rates for bulk purchasing. Because of the arguments, both pro and con, on this point, there has never been universal agreement within the industry to provide public network communications at rates that are discounted with large scale purchasing. The introduction of WATS is a step in this direction although it is not available from all telephone companies.

Significance of Private Line Services for the Carriers. Due to the size and inertia of the public network, updating it with new technology to handle new needs is usually undertaken when a new requirement has been reasonably well established. Developing this market can be done under the concept of private line services. Television channels, for instance, were introduced as private lines and were extended across the country to serve the broadcasting industry. This expansion pushed the development of new technology, including microwave carrier systems, and made it possible to provide capacity for other private line services for the incremental cost of expanding the system. Thus, Picturephone is being considered on a restricted basis. Similarily, broadband data transmission techniques have been introduced on a private line basis, utilizing this carrier technology. As the market for these services grows, decisions can be taken regarding their inclusion in the public network.

From the CN/CP point of view, the majority of their telecommunication services are of a private line nature. The growth of their market relies, to some extent, on the development of services attractive enough to coax users away from the public network as well as to serve new and developing needs. The market can, therefore, be influenced by the effectiveness with which the telephone companies meet these needs with the public network.

From information supplied by both CN/CP and the Trans-Canada Telephone System, it would appear that the two carriers almost share the private line market on a 50-50 basis. In 1969, the Trans-Canada Telephone System reported a revenue of $58.3 million, whereas the CN/CP revenues were reported as $68.6 million. The TCTS figures are only approximate and, if anything, probably pessimistic, since they do not include intra-provincial private line services, or private line circuits such as foreign exchange, tie trunks and circuits leased to other carriers. (See Appendix B). The Trans-Canada Telephone System revenue for private line represents about 5% of total operating revenue derived from message toll and private services. In spite of a growth in private line services of nearly 15% per year, the impact on the total operating revenue remains constant due to the corresponding growth in total operating revenue for TCTS.

Statistics in Appendix B reflect the revenue positions of both CN/CP and the TCTS with respect to private line services.

CHAPTER III

The Canadian Regulatory Environment for Private Line Services

Jurisdiction

In Canada, the principal regulatory control over a telecommunications carrier is exercised by either a federal or a provincial regulatory body. Certain telephone companies come under federal jurisdiction, others fall under provincial jurisdiction. Similarly, some of the railway telecommunication carriers fall under federal jurisdiction while others are regulated by the provinces.

This type of individual jurisdiction over carriers relates, however, primarily to the quality of service and the economic aspects of the carrier's operations. Other matters, such as the radio frequency spectrum and the crossing of navigable waters, are completely under federal jurisdiction. Furthermore, a carrier may have to deal with several federal agencies, provincial departments, or municipal authorities with respect to crossing roads, highways and railways.

Several statutes are relevant to the federal government's jurisdiction, principally (a) The Railway Act (b) The Radio Act, (c) The Telegraph Act, (d) The Canada Shipping Act, and (e) various Acts of Incorporation. For the purpose of this study the federal legislation of principal importance is the Railway Act, which provides the Canadian Transport Commission with the authority to approve tolls of telecommunication companies within the legislative authority of the Parliament of Canada.

The provincial regulatory powers are found in various provincial Acts and are exercised by provincial regulatory boards and/or executive bodies. A summary of the important legislation in this area, for each of the provinces, has been prepared in conjunction with Telecommission Study 1(a).

Significance of the Legislative Situation

The nature of the current legislative situation in Canada points to two facts which are significant for this study of the regulatory problems associated with private line services. First of all, since there are various jurisdictions, there will not necessarily be a uniform approach or philosophy with respect to the regulation of private line services. Secondly, action taken by federal regulatory authorities is, at present, limited to companies under their jurisdiction. Of course, in matters related to radio facilities, this jurisdiction covers all companies.

The significance of these two points is related, of course, to the fact that private line services have developed in a competitive environment. Public telephone services are treated as a natural monopoly and each carrier has a franchise area which is universally respected by other telephone companies. However, this franchise does not necessarily apply to private line services. Such services may be available in a given area from two or more carriers and also from entrepreneurial sources. This type of situation is particularly identifiable in areas where the railway carriers, who are large suppliers of private line services, operate in competition with the telephone companies. Thus, one carrier, operating under regulation, may be offering private line services in exactly the same area where another carrier is offering the same service under dissimilar regulatory conditions.

Summary of Jurisdictions

A Summary of the federal and provincial regulatory bodies and the major telecommunication carriers under their jurisdiction is presented below.

Federal Jurisdiction

Regulatory Body	Major Regulated Telecommunication Companies
Canadian Transport Commission	1. Bell Canada 2. British Columbia Telephone Company 3. The Bonaventure & Gaspé Telephone Co. Ltd. 4. Canadian National Telecommunications 5. Canadian Pacific Telecommunications 6. Québec North Shore and Labrador Railway 7. The Algoma Central and Hudson Bay Railway Company
Department of Communications	All users of the radio frequency spectrum.

Provincial Jurisdictions

Regulatory Body	Major Regulated Telecommunication Companies
1. British Columbia Public Utilities Commission	Okanagan Telephone Co.
2. Alberta Public Utilities Board	Alberta Government Telephones
3. Manitoba Public Utilities Board	Manitoba Telephone System
4. Ontario Telephone Service Commission	Northern Telephone Ltd. Thunder Bay Telephone Department
5. Québec Public Service Board	Québec Telephone Co.
6. New Brunswick Board of Public Utilities	New Brunswick Telephone Co.
7. Nova Scotia Board of Commissioners of Public Utilities	Maritime Telephone and Telegraph Company
8. Prince Edward Island Public Utilities Commission	Island Telephone Co.
9. Newfoundland Board of Commissioners of Public Utilities	Newfoundland Telephone Co. Labrador Telephone Co.
10. Government of Saskatchewan	Saskatchewan Telecommunications

Current Regulatory Situation

In view of the significance of the various regulatory approaches to the regulation of private line services, this study attempted to establish the current situation in each of the major jurisdictions. A request for relevant information was directed to both the regulatory bodies and the regulated telecommunication carriers. This information is presented in the following sections.

Canadian Transport Commission

The regulatory situation with respect to private line services provided by federally regulated carriers is in a period of change. During this study, legislation was introduced into the federal Parliament for changes to the Railway Act concerning the regulation of these services. Therefore, it is necessary to describe the current situation in terms of the immediate past as well as the immediate future.

In the past, the Railway Act, provided the Canadian Transport Commission the authority to approve telephone or telegraph tolls charged by companies to which the Act applied and to revise those tolls from time to time. This authority did not extend to private line services; however, the Commission could regulate a company's overall rate of return.

Although the Commission had no power to regulate private line services directly, it was very much concerned that the prices charged for such services did not result in a burden upon the regulated services. Therefore, it required companies, such as Bell Canada, to furnish evidence of revenues and costs for such services, when they were applying to the Commission for increases in their earnings on regulated services. Obviously, if the Commission was not satisfied with the level of earnings on such unregulated services, it could not directly order the telecommunication company to increase its charges for such services. However, it could limit the amount of increase applied to the regulated services and suggest that the company explore ways and means of obtaining any shortfall of revenue from unregulated services and other investments.[1]

1 The judgment of the Railway Transport Committee, dated September 25, 1969, concerning application by Bell Canada for a general rate increase is worthy of note. In Section 7(g), of the Judgment the Committee stated:

> "In nonregulated services, certain rate increases were put into effect in 1969; our decision herein does not preclude Bell from seeking higher earnings through sources of revenue or income which are not involved in the application.

During 1969, in response to various developments in the telecommunications industry, in particular the increasing complexity of the relationship between computers and telecommunications, the Minister of Communications introduced an amendment to the Railway Act to remove the private wire exemption.[3] Bill C-11 was passed by the House of Commons on January 28, 1970, received Royal Assent on March 17, 1970, and came into force on August 1, 1970.

The Canadian Transport Commission now has the authority to regulate private line services, within the scope of the Railway Act, of the telecommunication carriers under its jurisdiction. It should be noted that this scope relates almost entirely to economic factors.

The Department of Communications

Radiocommunications in Canada are subject to the jurisdiction of the federal Parliament. Under the provisions of the Radio Act, the Minister of Communications may prescribe classes of licences and of technical construction and operating certificates. The Minister may issue licences in respect of radio stations and radio apparatus, to the extent that they are not broadcasting undertakings, and issue technical construction and operating certificates in respect of radio stations and radio apparatus, to the extent that they are broadcasting undertakings. The Minister may issue these licences and certificates for such terms and subject to such conditions as he considers appropriate for ensuring the orderly development and operation of radiocommunication in Canada.

In addition, the Radio Act provides that the Minister of Communications shall regulate and control all technical matters relating to the planning for and the construction and operation of all radio facilities, and may make regulations pertaining to these responsibilities as set out in the Act.

Under the terms of the Government Organization Act, 1969, the Minister of Communications has the responsibility of promoting the establishment, development and efficiency of communications systems and facilities for Canada.

2 For a full treatment of the background of Bill C-11 see: Standing Committee on Transport and Communications. Minutes of Proceedings and Evidence, House of Commons, Nov. 18, 1969.

Provincial Jurisdictions

The Provincial Regulatory Boards of Commissioners were asked for information about the extent to which provincial legislation permitted them to regulate the private line services of telecommunications carriers under their jurisdiction and, where appropriate, the manner in which any such authority was exercised. In particular, information was requested on:

> The particular sections of provincial statutes authorizing the Commission (or Board) to regulate private-line services;
>
> The general approach adopted in exercising such authority;
>
> Specific regulations and requirements applicable to private-line services, indicating whether rates are submitted for approval or only for information; whether there is a requirement to identify investment and costs associated with private-line services; and whether regulations apply to all, or only some, of the services offered by the carriers;
>
> Any regulatory factors, such as approval of capital expenditures or new service offerings, which are applied to the carriers' operations as a whole giving, in effect, a degree of regulatory control over the private-line offerings.

The substance of the replies to these queries is given in Appendix A, but may be briefly summarized as follows:

> In Newfoundland rates for all services, public or private, must be submitted to the Board of Commissioners of Public Utilities for approval. The Commission exercises an overall regulatory control over the telephone company on the basis of a reasonable return on the rate base. It must also approve all new projects and undertakings in excess of $25,000.
>
> Legislation in Prince Edward Island does not indicate specific requirements and regulations applicable to any particular type of service. In general, the Public Utilities Commission considers that regulation of the utility applies to all services offered by the utility and no service to one class of customers is allowed to be subsidized by other customers. A utility also requires Commission approval on new construction and extensions and improvements costing more than one thousand dollars.

In Nova Scotia, private line voice service is considered an integral part of the telephone service and is subject to regulation. Other private line services are not subject to regulation but the Board of Commissioners of Public Utilities does require assurance that there is not subsidization of non-regulated services by regulated services. The Public Utilities Act requires approval of new construction in excess of $5,000.

The New Brunswick Board of Commissioners of Public Utilities has never made any regulations concerning private line services; however, it has indicated policies in individual situations. These decisions have accepted the view that the Board had no regulatory power over a private line service that was not tied in with the public telephone service and that was being provided on a competitive basis. No private line rates are filed with the Board; however, they are available for examination.

The Ontario Telephone Act makes no reference to private line services as such; nevertheless, the wording of the Act could be construed as providing for the regulation of these services if they were associated with a telephone exchange service. The Ontario Telephone Service Commission has not actively sought to regulate the private line leases of the telephone companies under its jurisdiction. However, it has regulated, by general Order, some of the more common and frequently required services.

The Québec Public Service Board has full regulatory jurisdiction over private line services. At present these are dealt with individually. However, a general order on the subject is expected to be proclaimed soon. Rates are submitted for approval and the telephone companies must specify investments and relative costs associated with private line services.

The Manitoba Telephone System does not submit private line rates to the Public Utilities Board, nor does it seek approval of the Board for new undertakings.

Saskatchewan Telecommunications, or "Sask Tel", is a Crown Corporation of the Province of Saskatchewan, and is not subject to a formal regulatory authority. It is self-regulated through its cabinet-appointed directors and responsible minister. Sask Tel must publish its rates and, when a private line service is well established and a firm offering of the service can be made, the rate is also published. The corporation must seek approval from the provincial government for major financial transactions and major tariff changes.

In Alberta, the Public Utilities Board does not appear to have dealt with the matter of regulating private line services and there may be some question as to the adequacy of the legislation to cover such services. The telephone companies do not submit rates for private line services, either for information or approval, nor is there a requirement to seek approval of new service offerings.

In British Columbia, most of the private line services are provided by B.C. Telephone Company or CN/CP Telecommunications, which are both federally regulated. Therefore, the involvement of the Public Utilities Commission with these services is quite limited. In general, the Commission does not differentiate between public or private line services and regulates on an overall basis. It also requires new service offerings to be submitted for approval.

CHAPTER IV

Issues Concerning the Regulation of Private Line Services

Identification of Problem Areas

One of the primary objectives of this study was to identify problem areas that could be attributed, totally or in part, to the regulatory environment for private line services. These problems have been assessed from the perspective of both the users and the suppliers of such services.

To achieve this objective, the project team attempted to obtain inputs from any interested party. These inputs were received in a variety of ways: there was direct input material for this study; indirect inputs from other studies; and informal communication through members of the project team. In addition, the project team conducted its own research to determine existing or potential problem areas.

In view of the diversity of the inputs for this chapter, no attempt was made to organize the material according to source. Instead, the material has been synthesized to identify the major points that have emerged.

Possible Problem Areas for Users of Private Line Services

Lack of Rate Regulation. An absence of rate regulation for private line services is often alleged to be a real or potential problem for users of these services. Without any regulation of rates the carrier is able to set specific tolls for the service, and the user has no recourse to any regulatory body.

The seriousness of this alleged problem is proportional to several factors, the most salient of which is the degree of choice open to the user. Generally, the absence of rate regulation has been taken to indicate that there are several sources of supply for the private line services. For example, in many areas of Canada the customer may obtain private line services from the telephone company or from a railway telecommunications carrier. In some situations the user also has an alternative of constructing and operating a private system. However, unless the system involves radiocommunications there is generally a barrier associated with obtaining necessary rights-of-way. Furthermore, the Department of Communications has recently requested many potential users of private radio systems to obtain the service, if possible, from the telecommunications carriers.

There are considerable limitations to the viability of the basic competitive situation between the telephone companies and the railway carriers. For example, there is often an equivalence in rates between the TCTS and CN/CP Telecommunications for a private line service. Furthermore, in the determination of revenue requirements for special private line services, the carriers sometimes recognize the cost of the users' alternatives and reflect these in their own rates for that service.

The oligopolistic situation does not apply to all services or in all parts of Canada. Therefore, it is dangerous to rely upon it as a means of insuring fair and reasonable rates for private line services. The choice between a telephone company and a railway carrier is generally restricted to inter-city facilities. A user who requires private line services within a major urban centre is usually faced with obtaining these services from the telephone company serving that area.

Another relevant factor which is often referred to in this context is that the telecommunications carriers are not completely without restrictions. While the Regulatory Board may not regulate specific rates for private line services it often casts a critical eye on these rates when examining requested increases in rates for the Public Services. The purpose of this scrutiny is, however, usually to insure that the private line rates are not too low, which would place an undue burden on the public services.

Cross Subsidization. The question of cross subsidization between regulated and unregulated services is an issue which invariably arises. It is not a problem unique to the users of private line services. As a matter of fact, it is more often assumed to be a potential problem for the users of the public telecommunications services.

The rationale for this assumption is based on the concern that any unregulated services are generally competitive in nature. Consequently, these services are apt to be priced to meet competition and therefore provide a return which is less than that provided by the public services. Furthermore, the allocation of costs, which is often the basis for determining rates, may be quite arbitrary and consequently is subject to dispute. There is often a feeling that regulation of private line services would provide a framework for examining and approving the cost allocations. In recent general rate increase applications, the intervenors have raised this issue at the public hearings and have focused on the adequacy of the returns for private line services.

The impact of the cross subsidization issue on the users of private line services is not clear. However, there exists a distinct possibility that as a regulatory jurisdiction moves to specific rate regulation of private line services, the rates may move upward rather than downward.

Pricing Policies. In the absence of regulation of private line services, there exists a possibility that a telecommunications carrier could adopt a pricing policy for a particular service(s) that would reduce the effect of competition. Any resulting elimination of the alternative sources of supply would leave the carrier in a monopolistic situation.

The fact that the two sources of supply for most major private line services are the railway carriers and the telephone companies, which are both subject to the constraints of an overall regulatory umbrella, considerably lessens the significance of such a possible problem. However, it should be recognized that private services such as those offered by a restricted common carrier for land mobile radio services or entrepreneurial Paging Services could be particularly vulnerable to the pricing practices of the large telecommunications carriers.

Technical Adequacy. Advancing technology is placing ever increasing demands on the technical adequacy of the telecommunications services available from the telecommunications carriers. This has become particularly evident for the data transmission facilities required by the computer companies, and the switching and control facilities required by electric utilities.

The services offered by the carriers are generally standardized in terms of technical parameters that have been designed to meet the needs of the majority of their users and to meet standards developed on national and international levels. The great investment in existing plant and equipment results in a considerable inertia towards rapid changes. Some users of certain private line services, such as data users, view the inability or reluctance of the telecommunications carriers to meet new and rapidly changing technological requirements in the private line service area as a serious problem.

Identification of Private Line Services. In a regulatory jurisdiction where the public services are regulated and the private line services are not, there is a grey area of demarcation between the two types of services. As a result of this situation, some services which users consider as "public" in nature may be in fact unregulated.

This type of problem can be compounded by an evolution of a service. Changes in the market for a service, which was originally private in nature, can result in that service becoming universally accepted and utilized. Such a change moves the service towards the "public" end of the services continuum. However, where private line services are excluded from regulation, particularly by specific legislation, there is generally a considerable lag in bringing the service under the authority of the regulatory body.

The teletypewriter exchange service which is offered by both TCTS (TWX) and CN/CP Telecommunications (Telex) is a service which has had this type of life profile. It was originally considered a private line service; however, over the past few years it has grown to include approximately 24,000 subscribers. From this point of view it would appear that these subscribers might be considered as receiving a public service which should be regulated.

Use of Rights-of-Way. The telecommunications carriers have acquired rights-of-way throughout their service areas for the development of their distribution systems. In general, the carriers do not appear to regard the use of these rights-of-way by others as the provision of a service.

There is one class of users of telecommunication services, namely the CATV companies, which feels that the carrier should not be permitted to prevent a joint use of rights-of-way when it is required by another "carrier". These companies take the position that there should be an effective regulatory control over the use of rights-of-way, poles, conduits, and other devices offered by the carrier so as to ensure a development of telecommunications that would be in the public interest.

Conditions of Service. In a regulatory environment for private line services, which does not provide some regulatory control over the type of service offered and the conditions under which it is offered, the users of those services can face particular difficulties.

One of the primary difficulties could be, of course, that of obtaining the type of service which meets their needs. This problem is one which has been particularly evident in the case of the the data processing companies. On the other hand, a company which has organized itself around a particular user-leased communications system looks very unfavorably on changes in the service(s) provided by the carriers that could disrupt their operations.

Conditions of service relating to interconnection of user-owned terminal devices and communication systems, and the sharing of facilities are good examples of contentious matters that could arise between users and the telecommunication carriers.

Possible Problem Areas for Telecommunication Carriers

Impact of Competition. The variety of regulatory jurisdictions in Canada and the competitive nature of private line services may result in the unique situation of a carrier offering regulated private line services in competition with an unregulated supplier of an identical or similar service.

Such a situation will exist, for example, for CN/CP Telecommunications services in Alberta. The private line services of Alberta Government Telephones are not regulated by the Alberta Public Utilities Board whereas such services offered by CN/CP will be regulated by the Canadian Transport Commission. Similar situations will exist in other jurisdictions such as New Brunswick, Ontario, and any other province in which a provincial telephone company is unregulated with respect to private line services.

The telecommunication carriers feel that this type of situation will present a serious problem if they are prevented by legislation, or by the regulatory approach of their Board, from freely meeting competition.

Cost Separations. In a modern, complex telecommunications system, the facilities which are used to provide private line services are often technically integrated with the facilities which provide public telecommunication services. The inter-city toll facilities are generally provided by high capacity microwave systems. These systems may, for example, be simultaneously carrying hundreds of telephone conversations, private line voice circuits, TWX, and network television.

Since a wide variety of telecommunication services are provided from common plant, it is often indicated by the carriers that the identification of costs associated with a particular service, or class of services, poses a problem. Regulation of private line services may require such cost separations, and there appears to be a range of views as to the difficulties involved.

Inability to Test Markets. Some of the private line services offered by the telecommunications carriers are provided on a special assembly basis and provided to the customer at a custom rate for the particular service. However, many private line services such as private line voice, Teletypewriter Exchange Services, etc. are not custom rated, but are items which are generally provided to all customers at a similar rate.

When there is no rate regulation for these services, and when there is no requirement to file tariffs for them, the telecommunications carrier has considerable latitude in testing the market for these services. The carrier might, for example, set different rates for a similar service in different areas to determine the economic characteristics of the market. It might also provide different conditions of service to different customers when it feels there is a heterogeneous market for the service.

Under a traditional regulatory environment, this type of activity would probably be prohibited or severely restricted.

Specialized Nature of Some Private Line Services. Not all private line services can be developed into a general offering that can be tariffed as to rates and conditions of service. By their very nature, some private line services are custom offerings tailored to the needs of a customer and the rates are developed for the particular situation.

There are, of course, many private line services that are suitable for a general offering such as Private Line Voice, general land mobile, and Telpak. If the carriers were required to provide all private line services on a non-discriminatory basis, it might prevent them from offering customer services which could not be offered on a general basis or at a universal rate.

Non-optimization of Service. In a similar view to the previous point, it is possible that a rigid regulatory environment for private line services could inhibit the telecommunication carriers' flexibility in providing variations in private line services, in terms of such items as special conditions of service or service options. An inhibition of this nature could lead to user-leased communications systems being developed around existing tariffs rather than a meld of services custom-designed to meet the users' unique requirements.

Regulatory Alternatives

The regulation of public utilities is a subject that opens the door on a wider range of issues for discussion and debate. No attempt has been made in this study to examine fundamental questions concerning regulation. However, in order to provide the basis for some analysis and discussion of the issues surrounding the regulation of private line services, there is a need for a brief review of the basic regulatory alternatives.

There are many ways of considering the alternatives in this study - have been considered to fall along three dimensions. These are:

(a) the type of regulation

(b) the scope of regulation

(c) the degree of regulation

The Types of Regulation. The three basic types of regulation that are often identified can be described as economic, technical, and social. It is, of course, difficult to distinguish precisely between these types or to assign relative importance to any one of them. For example, technical regulation will often have an economic impact on the carrier and regulation with social objectives in mind will invariably have some interrelationship with economic and technical factors. However, the distinction is useful at a conceptual level for analytical purposes. In this study, which focuses on only one segment of the telecommunication carriers' offerings, namely private line services, it was considered that economic and technical regulation should be particularly identified.

Economic regulation generally involves a regulatory surveillance of a wide range of the carriers' activities. The exact extent of it depends, of course, on the powers granted to the regulatory body by legislation. The spectrum of factors involved in economic regulation always includes rates and may include other such factors as financing, corporate relationships, investment, return on investment, quality and conditions of service, methods of depreciation, accounting methods, to name only a few.

Technical regulation, on the other hand, involves a direct regulatory surveillance over the technical parameters of the telecommunications systems provided by the carriers. The stipulation of minimum technical standards for particular services, technical standards for communications equipment and systems, and the approval of the technical characteristics of carrier interface requirements constitute some of the major elements of technical regulation.

The Scope of Regulation. The scope of the regulation of private line services is indicated by the number of these types of service which are regulated. It is apparent that the alternatives form a continuum which ranges from no regulation of private line services, through the regulation of several specific services, to the regulation of all such services.

This conceptual dimension of regulation may not be of much practical value when considering the general subject of regulation. However, in the context of this study, it is important inasmuch as it is clear that such alternatives do exist with respect to private line services. From the information presented in Chapter III it is apparent that the scope of regulation varies among the regulatory jurisdictions in Canada. In New Brunswick, for example, there is no regulation of private line services. In Nova Scotia, private line voice circuits are regulated whereas other private line services are not. For those companies under federal jurisdiction, following the proclamation of Bill C-11, all private line services will be subject to regulation.

<u>The Degree of Regulation</u>. The degree of regulation exercised over private line services is another regulatory dimension that offers a range of alternatives to the regulators. It is suggested in this study that the degree of regulation also provides a continuum of alternatives ranging from environmental regulation to specific regulation of individual services.

Environmental regulation of private line services, at least from an economic perspective, is already the general approach used in most Canadian jurisdictions. Inasmuch as a regulatory body exercises a surveillance over the overall rate of return of a telecommunications carrier or seeks assurance that the unregulated services do not place a burden on the regulated services, it is reasonable to say that there is an environmental regulation of the private line or "unregulated" services.

The polar opposite to this degree of regulation is, of course, a specfic regulation which might require the identification of the rates, investments, and rate of return for each private line offering.

CHAPTER V

Summary and Discussion

This study was undertaken to identify and examine the problem areas that might be related to the regulatory environment for private line services. To provide a basis for an appreciation of these problem areas, the study presented a brief historical background of private line services; indicated the major concepts of private line services; and, attempted to place these services in perspective with some quantitative data. The study also reviewed the current regulatory situation for private line services in various Canadian jurisdictions.

In the previous chapter the possible problem areas were synthesized around two polar viewpoints: those of the users of private line services and those of the suppliers of private line services. The purpose of this final chapter is to highlight and discuss some of the major points that have emerged during the study.

The Concept of Private Line Services

From a historical perspective, private line services had their origins in the point-to-point facilities which were dedicated to serve a subscriber's private communication requirements. It was natural that a distinction would develop between these types of services and the "public" services of the telecommunication carriers. First of all, the private line services generally bypassed the switching facilities and, secondly, the rates and conditions were usually established on a special contractual basis.

From the information gathered for this study and the discussions that have taken place, it appears that there is room to question the validity of maintaining such a distinction for many of the contemporary "private line services". First of all, there is an intimate relationship between the physical plant and administrative structures associated with the provision of both public and private line services. Furthermore, many of the private line services do not have the basic technical characteristics of the earlier services which were provided on facilities that were physically identifiable and distinct. In fact, most private line voice and private data circuits use local loops that are an integral part of the switched network and inter-city circuits that share cable or microwave toll facilities with the public telephone network. An additional factor is the hybrid nature of some private line offerings. Telpaks offered by some telephone companies have, for example, come to include exchange connected services.

There is a variety of concepts as to what private line services really are and the issues concerning the regulation of these services vary depending upon the concept that is considered most appropriate. The concept that private line services are primarily a family of services for which predetermined patterns are available, and which may consequently qualify for particular rates based either on economies or premiums, suggests that such services are simply an integral part of the whole spectrum of services offered by a telecommunication carrier. From this perspective, issues relating to special regulatory considerations become less imperative.

This viewpoint would appear to be particularly appropriate in the case of a large number of private line offerings which could be considered to be "off-the-shelf" services. These services, such as private line voice, private line teletype or data, Telpak, Telex or TWX are generally offered by the telecommunication carrier on the basis of standard rates and conditions of service. Therefore, there is essentially a tariff for the service, whether or not this is filed with a regulatory board or whether it is simply an internal working document for the carrier.

This concept of private line services is, of course, not universally applicable and it is necessary to highlight some of the distinguishing features of private line services that hinder any oversimplification of the regulatory situation. First of all, these services do not generally have access to the switched networks; secondly, the facilities used to provide the service are usually dedicated to the user for some continuous period of time; and thirdly, there is often a choice of supplier for these services.

It is worth while noting the concept which views private line services to be those telecommunication services which are provided to a customer by means of facilities that are exclusively dedicated, for any period of time, to serve his telecommunication requirements. This concept was very useful until developments in the industry eroded its viability. As noted in the study, private line services are now available on a switched network basis. Telex and TWX are good examples and switched broadband facilities are developing rapidly. Developments such as these obviously move these services outside the scope of this concept of private line services; however, the related problem of regulators is perhaps more than one of simple conceptualization. To regulate these services the legislative definitions must be adequate and some problems have apparently arisen in this regard where the definitions were framed in outdated technology. Another factor which weakened this concept was the development of multi-purpose offerings which embraced both regulated and non-regulated services in a single offering.

It is recognized that any simplified view of private line services which serves to minimize the existence of regulatory problems immediately merits some qualifications. These are called for when those private line services, generally classed as "special assemblies", come up for consideration. Services provided on a special assembly basis are usually custom designed and custom rated to meet the individual needs of a particular customer. The private switched networks for the Department of National Defence and General Motors are examples, as are the specially constructed microwave links serving some broadcasters' requirements for TV transmission.

It is apparent that there are difficulties for the telecommunication carriers with respect to filing tariffs for custom designed services. It is probable that the carriers can set forth the general criteria used for pricing such services and identify the manner in which they arrive at costs. However, this falls considerably short of filing tariffs for the tolls to be charged. Given an extrapolation of the traditional regulatory approach to these custom services, it is possible to visualize a catalogue of rates and conditions of service, each applicable to a single customer. The administrative problems, and the problems of assessing whether there are dissimilar circumstances surrounding two identical services being offered at different rates, are only a few which may assail the regulator of these types of services.

Other services which do not neatly fall into any simplified view of private line services are those which involve activities such as equipment leasing. Most telecommunications carriers lease radio equipment for private land mobile systems; private radio paging systems; or private intercommunication systems. In this area, the carriers compete directly with a wide range of equipment suppliers. Activities such as these, which involve the leasing of equipment that is not associated with the provision of service, move the carrier into a sector of the telecommunication industry that is highly competitive and which is somewhat unrelated to the basic function of a "telecommunications carrier".

With these observations concerning the concepts of private line services in mind, a brief discussion of the regulatory alternatives for private line services may serve to highlight some of the issues.

Discussion of the Regulatory Alternatives

In the previous chapter, it was hypothesized that both the economic and technical regulation of private line services could be visualized in terms of two dimensions: the scope of the private line services regulated and the degree of regulation of the services.

Although this may provide an orderly approach for analysing issues concerning the regulation of private line services, it may not necessarily be the best starting point. It was a common observation that the most desirable point of departure is the objectives of the regulation. A full appreciation of the objectives is essential to an evaluation of the alternatives.

Economic Regulation. Any attempt to discuss whether some, or all, private lines services should be specifically regulated immediately raises a host of basic issues. The degree of competition that is desired in this area of telecommunications is only one such issue.

There are, however, some observations that might be valuable. There are a number of carrier activities, generally classified as private line services, which fall at the outer limits of the telecommunications carrier function. Equipment leasing, which was discussed earlier, is one example. The leasing of computer processing capacity (without telecommunication facilities) is another. A more extreme example might be the leasing of spare office space. All these sources of income are essentially unrelated to the basic role of a telecommunication carrier and consequently may deserve some careful examination as to the degree of economic regulation that is necessary.

In most of these types of activities the carriers are competing directly with a wide range of other suppliers. A degree of economic regulation that involves the filing of lease rates for specific pieces of equipment might prove to have practical difficulties. If exclusions are judged advisable, the manner in which they are identified warrants careful consideration. Any definitions in legislation that are based on technology are apt to cause future difficulties. Exclusions based on clearly definable service categories or which derive from the statement of objectives would appear to avoid the most obvious future problems.

It is amply evident that the degree of economic regulation that should be considered for individual private line services is an issue for which few answers can be found in this study. There is, however, one generalization that would appear to be valid. In most jurisdictions, private line services of all types are at least subject to an environmental type of regulation. This observation would in fact apply to any activity that is undertaken by a carrier itself (as opposed to a subsidiary). These activities and services are regulated inasmuch as the carrier's regulatory body seeks to ensure that they do not impose any undue burden on the regulated services. Moreover, in most jurisdictions, there is some control exercised over the rate of return earned by the carrier. This degree of regulation exercises some economic constraints on the private line services.

Turning to the degree of economic regulation that might be considered for individual services, two observations can be made. First of all, if there is validity in the impression that there is a diminishing difference between a large number of private line services and public services, then it would follow that the degree of regulation for such services need not differ substantially from that which is applicable to all services generally. Secondly, there may nevertheless be particular services, such as those for which there are alternative suppliers, that might merit special consideration with respect to the degree of economic regulation.

Technical Regulation. The subject of technical regulation, although encountered during the course of the study, did not emerge as a particularly strong issue. Rather than technical regulation *per se*, i.e. a regulatory body charged with the responsibility for setting technical standards for various classes of private line services, it appears that users are more interested in issues relating to means of ensuring that telecommunication carriers will:

(a) introduce services with new or different technical characteristics as markets develop for these services;

(b) maintain the technical standards of service that are specified in the service offerings;

(c) design rates for service offerings that reflect any differing technical standards.

With respect to all these points, one is struck by the fact that they are closely related to costs and rates and that there are strong economic overtones to all of them. In fact, differentiation between economic and technical regulation may be oversimplifying the matter. For example, with reference to point (a) above, it is generally true that a carrier can introduce a private line service with any technical characteristics a customer desires, at least on a special assembly basis, provided the customer is willing to pay for it. Also, when the question is raised of introducing new private line services as a general offering, one can expect to find that the basic issues have their roots in economic considerations. The need to replace obsolescent plant to provide a new generation of private line services would have a significant impact on the economic aspects of the carriers' operations.

Consequently, while it is possible to distinguish conceptually between economic and technical regulation, it appears that basic issues preclude any narrow view of technical regulation. Consideration of technical parameters appears to merge quickly with the regulatory body's overall function of regulating the carrier. The key requirement from a user's point of view seems to be for an impartial body to which they have reasonably easy access and which would be able to assess issues relating to technical quality and costs. The desirability of a regulatory body charged with directing the introduction of new facilities and services must also be tempered by the realization that a Commission that had directed a telecommunication carrier to introduce a new service would be in an extremely difficult position if the carrier subsequently came forward with a request for rate increases to support its introduction.

There are also some obvious difficulties with any approach to technical regulation that involves the setting of standards of technical quality for various private line services. If such standards were developed within a rigid framework, rapidly developing communications technology could easily lead to the standards becoming too high for some users and too low for others. Furthermore, technical quality is multi-dimensional; therefore, changes in standards to improve one parameter might degrade another.

Impact on Users

When the several possible problem areas for the users of private line services are viewed in terms of regulatory alternatives, it appears that economic regulation would considerably lessen the basis for user complaints. An emphasis must, of course, be placed on the word "basis". It is possible that rate regulation of individual private line services, which would delve into elements of cost, return on investment, and value of service, might lead to increases in some rates

rather than a decrease. Such an eventuality would probably lead to further user complaints; however, there should be little ground for allegations of discrimination, unfair allocation of costs or unfair competitive practices if the rates had been scrutinized by the regulatory body.

It appears that economic regulation focused solely on an approval of rates for private line services would not completely eliminate all of the possible problem areas that could arise for users of these services. However, as noted earlier, any problems associated with the terms and conditions of service or the technological aspects of private line offerings are closely allied to economic considerations. If the scope of a regulatory body's surveillance over the economic activities of the telecommunication carrier were broad enough, or if they were framed in terms of objectives which would permit the regulator to take all relevant factors into consideration, then the basis for many of these types of problems might also disappear. One of the major factors in the regulation of private line services, from a user's point of view, would be the fact that there was an independent body to which he had recourse for matters relating to the provision of private line services, whether they be economic or technical.

Impact on Telecommunication Carriers

One of the carriers' primary concerns relates to the competitive nature of some private line services. They fear that the regulated carriers may be placed at a serious disadvantage _vis à vis_ those whose private line services are unregulated or those suppliers of similar services who are under no economic regulation whatsoever. This concern is evidenced by the fact that the TCTS study group has conceptualized private line services as those which can be obtained from one or more supplier.

It is difficult to assess the real difficulties that a regulated carrier will encounter when offering regulated service in a competitive situation; however, certain points have been raised during the study that are worth discussing. First of all, the basic concern of a carrier about the competitive nature of private line service appears to be based on the assumption that it will have to compete with a rate structure that is both fixed and exposed. This assumption would not necessarily be valid if legislation enables the regulatory body to recognize and assess the competitive elements with respect to a particular service. Under these circumstances the carriers could possibly be freed, within the regulatory framework, to meet competition for a particular service if it so wished.

Another set of alternatives hinges on the minimization of any real competition with respect to the provision of private line services. An exploration of these alternatives is beyond the scope of this study; however, one important element should be noted. One aspect of the problem arises from the complex jurisdictional situation in Canada in which there can be two carriers offering private line services, one of which is regulated with respect to these services while the other is not. Continuing efforts to obtain a common viewpoint with respect to the regulation of private line services, to the extent that differing legislation will allow, is an important consideration. Another consideration, which is not evaluated here, is the federal regulation of all interprovincial private line services with a view to reducing the disparities among the approaches of different regulatory bodies.

Another point of interest relates to the degree of competition that actually exists in the "competitive situations". In general, the major competition for private line services is between the TCTS members and CN/CP Telecommunications. However, this competition relates primarily to services using intercity toll facilities. By virtue of their monopoly position in the switched telephone network, the telephone companies have an advantageous position for the provision of private line services requiring the plant associated with exchange services. CN/CP Telecommunications must lease local loops from the telephone companies to off-end traffic for most of their private line services. Therefore, for a majority of the private line services there is, at best, only competition between two major suppliers.

Given this degree of competition it still appears that there is very limited price competition in many of the "off-the-shelf" services such as private line voice and private line teletype. There are, in fact, indications of a "price leader" - "price follower" relationship between the two carriers. Price competition emerges most markedly in the "special assemblies". In this area, although the carriers appear to base their lease rates on incremental costs, there seems to be some recognition of what a competing carrier can offer or what the prospective user can provide for himself.

Companies which offer Restricted Common Carrier Mobile Radio Services (RCCMRS) constitute another group from which the telecommunication carriers face competition. The services provided by Restricted Carriers do not provide interconnection with the general land telephone system.[1] Therefore, they do not compete with the general land mobile system provided by a telephone company which is integrated with the switched network (this latter service is, of course, not a private line service). However, some telephone companies also operate RCCMRS systems. To the extent that they do, they could be in direct competition with an unregulated, entrepreneurial operation.

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1. The RCCMRS was established to provide two basic classes of service: (a) Remote Dispatch; and (b) Message Relay.

There is, however, some area for discussion as to the degree that the entrepreneurial systems are unregulated. While it is true that there is no specific rate regulation, the Department of Communications exercises technical regulation with respect to the equipment that is used for a RCCMRS and the companies' technical competence. Furthermore, DOC inquires into the financial competence of applicants for such systems, and limits the licences for such systems to one per urban area. Two licences are permitted in areas with populations over 500,000. Therefore, it appears that any major issues concerning competition between a telecommunication carrier operating a RCCMRS under rate regulation and a business venture operating a system without rate regulation would be restricted to the larger urban areas.

It might also be noted that the problems that might possibly arise from such a situation are not entirely confined to the regulated telecommunication common carrier. In the United States, businesses offering unregulated telecommunication services have appeared before Regulatory Commissions to claim protection against utility competition. There have been claims that it was the telephone companies' rates that were destroying competition because they were non-compensatory.[2]

The emergence of Telesat Canada as a telecommunication carrier to provide private line services adds, of course, another dimension to the Canadian scene. It is obvious that the domestic satellite system may offer major users a third alternative as far as long haul, inter-city facilities are concerned. Inasmuch as Telesat might be offering services that can compete directly with both TCTS and CN/CP Telecommunications and, since both these carriers will probably own part of the Corporation, the situation may present some special regulatory problems that will deserve particular attention.

Any accurate assessment of the impact of the regulation of private line services on the telecommunication carriers must, in the final analysis, depend upon the scope and degree of the regulation. The relative impact will also depend upon the carrier that is being regulated. From the figures obtained for this report, it appears that private line services represent a significant portion of the revenue for the railway carriers, while it is less than 5% of the toll operating revenue for the Trans-Canada Telephone System. Therefore, the impact of regulating these services will obviously be greater on the railway carriers who have, prior to the implementation of Bill C-11, only been regulated with respect to their telegraph services and public telephone services.

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2. Trends and Topics "Utility Competition with Unregulated Business", <u>Public Utilities Fortnightly</u>, September 25, 1969, pp. 53-5.

APPENDIX A

INFORMATION RECEIVED FROM PROVINCIAL

REGULATORY BOARDS CONCERNING THE

REGULATION OF PRIVATE LINE SERVICES

This Information Provided By:

Province of Newfoundland and Labrador
Board of Commissioners of Public Utilities

The Newfoundland Public Utilities Act does not contain any specific provisions relating to the provision of private line service. "Service" is defined in the Act as the use and accommodation afforded users and no public utility is permitted to charge any compensation for any service performed by it whether for the public or under contract until it has first submitted a schedule of rates, tolls, and charges to the Board and has obtained approval for them. Any firm, person or corporation which owns, operates, manages or controls equipment or facilities for the conveyance or transmission of messages or communication by telephone or telegraph for compensation is a public utility for the purposes of the Act.

The general approach adopted in exercising regulatory authority is to determine the gross operating revenue required to meet all operating expenses, including depreciation and taxes, and to yield a reasonable return on the rate base which for all practical purposes is equivalent to the depreciated book value of the fixed assets plus allowances for cash working capital and average monthly inventories of materials and supplies held for maintenance purposes.

Rates for different classes of service are established by the Board after consideration of value of service and the rates being charged for comparable services in other areas. In establishing general tariffs the costs of providing the different classes of services are not required. When applications are received for approval of rates for new services, it is required that a carrier submit estimates of the capital cost of providing the new service, and the annual expenses associated therewith, including rate of return and the rates being charged by other carriers for similar services in the Atlantic Region. If the Board is satisfied interim approval is granted. Interim approval terminates when the next Order is made fixing a Tariff for the carrier. The law and the regulations apply to all telecommunications services furnished within the jurisdiction of the Board. The Board, of course, has no jurisdiction over service extending beyond provincial boundaries, neither does the Board exercise jurisdiction over non-telecommunications services; for example, yellow page advertising in supplements to directories.

It might be noted that the Newfoundland Telephone Company applied and the Board granted approval of rates for closed circuit television and frequency modulated transmission during 1969.[1]

Public utilities in the province are required to obtain the approval of the Board for expenditures in excess of $25,000 for any new construction, improvements or betterments in, or extensions, or additions to its property used or useful in furnishing any service.

This Information Provided By:

Province of Prince Edward Island
Public Utilities Commission

Regulation of all electric power and telecommunications is provided for under the Electric Power and Telephone Act.[2] Authorization is provided throughout the Act under various sections for regulation of different types of service. Section 1(d) provides for the interpretation of a "public utility" under the Act and Section 5 provides for certain other authority. Section 16(1) and (2) provides for the fixing of rates for all types of services provided by such a utility. Sections 20 and 21, as amended, provide still further authority relative to the fixing, varying and altering of rates.

The general approach to the fixing of rates is provided for in the various sections of the Electric Power and Telephone Act.[3] In considering any rate revision cases the Commission gives close attention to the generally accepted public utility practices, as determined by various rate cases throughout Canada and the United States.

Any valid complaint as to inadequate service is immediately brought to the attention of the utility concerned by the customer. If this brings no satisfaction, the matter is then referred to the Commission which has, to date, invariably resulted in a satisfactory solution being reached.

Specific regulations and requirements applicable to any one type of service do not exist under the Act. The levels of quality for private line services, such as program transmission, have been satisfactorily arrived at between the utility and the customer. All rates and charges are fixed by the Public Utilities Commission and may be determined in any one of several ways. However, in most cases,

1 For further details see, Province of Newfoundland, Board of Commissioners of Public Utilities, Twentieth Annual Report, 1969. pp 36-9.

2 Province of Prince Edward Island. The Electric Power and Telephone Act, R.S.P.E.I., 1951, c. 49.

3 Ibid., Sections 22 to 29 inclusive.

the utility makes application with a proposed schedule of rates and charges designed to yield a given level of return on a prudent original investment, less accrued depreciation. A practice adhered to by the Commission with regard to various types of services provided by a given utility is that no utility is allowed to provide services to one group or class of customer which would have to be subsidized by other customers of the utility. Regulation of the utility applies to all services offered by the utility, other than holdings of the company which do not concern the utility, and these must not represent any cost to the utility as such.

The utilities are not permitted to construct any line, plant or system, nor at a cost exceeding one thousand dollars make any extensions or improvements, without the approval of the Commission.[4] It is also interesting to note that the legislation permits the Commission to fix and determine a separate earnings base for each type of service furnished, or supplied to the public.[5] However, as mentioned above, the Commission has chosen to treat the utility as a whole and provide a rate which gives a reasonable return on the rate base of the utility as a whole.

This Information Provided By:

Province of Nova Scotia
Board of Commissioners of Public Utilities

In the Public Utilities Act the public utility is declared to include any person who owns, operates, manages or controls any plant or equipment for the conveyance of telephone messages. Service is further defined as including the conveyance or transmission for compensation by a public utility of telephone messages. Furthermore, a "telephone line" is defined as including all property used, operated, controlled or owned by a public utility to facilitate the business of affording telephonic communication for hire.[6]

As a consequence of these and other provisions in the Public Utilities Act, <u>private line voice service</u> is considered to be a public utility service and subject to regulation. It follows that private line voice service is dealt with by the Board as one of the regular telephone services to be provided by the Telephone Company and the rates for this service reflect the same general approach as is followed in determining exchange service and long distance rates.

Rates for regulated services provided by Maritime Telegraph and Telephone Company are designed on a province-wide basis under a rate schedule that reflects a considerable emphasis on value of service. Private line voice service is not considered

4 <u>Ibid.</u>, Section 6(1).

5 Ibid., Section 24.

6 Province of Nova Scotia. <u>The Public Utilities Act.</u> R.S.N.S. 1967., c. 258, Section 1.

to be a special or unusual service that would justify rates related to special capital or operating expense. The rates for private line voice service are determined by the Board in the same manner as rates for other regulated services and cannot be changed or verified, except upon application to the Board.[7]

In the Province of Nova Scotia services such as television and radio broadcast, T.W.X., teletype, private mobile telephone, wired music facilities, leased services such as alarm circuits, and leased facilities to other carriers, are not subject to regulation by the Board of Commissioners of Public Utilities. These, together with all out-of-province services including message toll, provide Maritime Telegraph and Telephone Company Limited's non-regulated revenue. Rates for these services are not submitted to the Board for approval or for information, or at all, and there is no requirement that the investment and costs associated with these non-regulated private line services be identified. The Board, however, upon applications made to it for approval of General Tariff changes in the rates for regulated services requires evidence from Maritime Telegraph and Telephone Company Limited and statements of its officials to give assurance to the Board that in the view of management the revenue from regulated services does not subsidize the non-regulated services and that the Company's participation in non-regulated services is beneficial to the quality and price of regulated services. The Board does not require separation of costs but is extremely interested in the outcome of the direction contained in the September 25th, 1969 decision of the Canadian Transport Commission, Railway Transport Committee in the Bell Canada application.

The Public Utilities Act, Section 34, prohibits a public utility from proceeding with any new construction, improvements or betterments in or extensions to its property, which requires the expenditure of $5,000 without first acquiring the approval of the Board. This Section has proved to be most useful in enabling the Board to consider in advance the purposes and propriety of capital expenditure, especially major capital expenditures. It has also been most useful in enabling the Board to require Maritime Telegraph and Telephone Company Limited to lay before the Board, in addition to estimates of costs, estimates of revenue when capital expenditures are being approved for the installation of facilities to provide both regulated and non-regulated services.

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7 Ibid., Sections 60-67 inclusive. These sections indicate the nature and extent of the regulation of telephone rates in Nova Scotia.

This Information Provided By:

Province of New Brunswick
Board of Commissioners of Public Utilities

The only provincial statute authorizing the Board to regulate the private line services is the Public Utilities Act. No regulations have ever been made by the Board, although policies have been declared from time to time over the years, and it has attempted to follow court procedures with the usual amount of latitude traditionally allowed by administrative tribunals.

The question of private line rates arose in 1962 when a complaint was lodged by the Board against New Brunswick Telephone in respect to certain practices of the utility in the field of private mobile radio service. The Board decided at that time that private mobile radio service was not tied in with the public telephone service and, therefore, the Board had no regulatory power over this particular service.[8] In addition, this service was being provided on a competitive basis with others providing the same type of service.

In 1963 an application was made by New Brunswick Telephone for the deletion of private line telephone service from the General Tariff. The reasons brought forward by the Utility at that time were that it was not a service that was accessible for use by the general public, in that, it was supplied and was only available for use between predetermined specified terminals and was not connected for intercommunication with the company's general local or long distance network. On May 17, 1963, an order was issued by the Board approving this deletion and since that time, the rates for private line telephone service have not been filed with the Board. They are, however, available for examination by the Board at all times, inasmuch as New Brunswick Telephone is always ready and willing to supply the Board with any information which is available.

The question of separation of costs to identify service and cost connected with private and other non-regulated services has come up occasionally, particularly with reference to the private line radio service and inter-provincial tolls. The Board has considered the separation of costs for these non-regulated services from time to time but has realized, after consultation with its auditors, that to place the burden for separating cost for non-regulated services with respect to inter-provincial tolls would be a tremendous and costly one. However, it should be noted that in the rate decision, which the Board handed down on December 3, 1969, it stated that New Brunswick Telephone should make a study to show the extent to which revenues derived from intra-provincial non-regulated revenues exceed the incremental costs of supplying such service.[9]

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8 For a report of the decision see: Province of New Brunswick, Report of the Board of Commissioners of Public Utilities, December 31, 1962, pp. 86-94.

9 Province of New Brunswick. Decision, Board of Commissioners of Public Utilities. December 3, 1969.

The Board does not exercise any particular regulatory control over capital expenditures which would have the effect of giving a degree of regulatory control over private line services.

This Information Provided By:

Province of Ontario
Ontario Telephone Service Commission

The Ontario Telephone Service Commission functions by reason of the Telephone Act.[10] The concern of the Act is regulation of public telephone service, its enfranchisement and interconnection. This Act makes no reference whatsoever to private line service as it is defined for this study.

Any regulatory power over private line services is therefore by implication, it being realized that, in practice, the public telephone system may conceivably experience customer demand for private line service. On this basis the Act might, by virtue of the definition of rate, be construed as providing for regulation of a service leased to a customer. Rate is defined as "any rental or charge for supplying telephone exchange service and all services associated therewith".[11] If this were conceded, then certain sections of the Act could apply to that private line service in the same manner as they do to public service.[12] However, it should be noted that the private line services could be regulated only if associated with the telephone exchange service.

The Ontario Telephone Service Commission to date has not actively sought to regulate the private wire leases afforded their customers by telephone systems under its jurisdiction. It has relied upon the norm of the industry to function as self regulator. Under this approach the telecommunications carrier and its private customer would negotiate directly and, if agreement is reached, the Commission would not necessarily intervene. If the carrier should appeal to the Commission for technical advice or advice in setting a rate, there is no doubt that advice would be given. If the customer should appeal, complaining of hardship, there is not doubt that the Commission would intercede between carrier and customer in an effort to establish agreement. It would be expected, in either situation, that the Commission would be guided by what it considered to be the current industry norm as to service and charge, together with any local factors bearing upon the case. It is furthermore certain that, should it become apparent to the Commission that a carrier's public service was suffering for some reason arising out of its private line activities, action would ensue to ameliorate such a condition.

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10 The Province of Ontario. The Telephone Act R.S.O., 1960, c. 394, as amended.

11 Ibid., Section 1(g).

12 Ibid., Sections 1(j), 6, 14, 15, 26, 100, and 105.

The private line cases dealt with would be specific hence no routine filing or checking is involved. However, by general Order, the Commission has regulated several services, which are of the nature of private line leases, and which have occurred with some frequency. These are as follows:

(i) Circuits for teletype use.

(ii) Circuits for program transmission.

(iii) Telephone co-ordinating circuits; for example: those for use with radio operation.

(iv) Inter-exchange and foreign exchange circuit mileage charges.

There are various regulatory factors which apply under sections of the Telephone Act which are applied to the carrier's operations as a whole, hence resulting in a degree of regulatory control over the private line offerings. These factors relate to borrowing; interconnection of systems; agreements affecting costs of public service, etc. [13]

This Information Provided By:

Province of Quebec
Public Service Board

By virtue of its constituting law, the Public Service Board has full jurisdiction to regulate the private cable services of the communications common carriers.[14] Whether it is a cable service for computer use provided by a telephone company or a cable service for audio-visual transmission, the Board has jurisdiction to regulate all these services even for the part of the operation which might require the use of radio waves to establish a link with another type of transmission terminal.

The present legislation allows the Board to exercise the necessary authority for purposes such as closed circuit production, local or regional consumption, even if there is use of antennas. However, the law will probably have to be amended to make it more precise and explicit on the matter of the Board's jurisdiction over radio operation.

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13 Ibid., See Sections 12, 13, 30, 33, 44, 48, 51, 61 63, 96, 99, 102, 109 and 115.

14 Province of Quebec. Public Service Board Act. R.S.Q. (1964), c. 229. Note specifically Sections 2(3) (a), 3, 15, 17, 18, 19, 20, 23, 24, 26, 27, 28, 30, 32, 33. Note also Standard Time Act R.S.Q. (1964) c.4. Under this Act, Section 4: the Board also has the power to regulate the schedules of the public services under its control.

The general way in which the Board exercises its authority at present is as follows:

(a) It approves plans for underground ducts submitted by the City of Montreal in accordance with its charter;

(b) It approves tariffs for the use of computer centres offered to the public by telephone companies which come under the Board's jurisdiction;

(c) It will approve, in the near future, tariffs, contract forms, installations and regulations concerning CATV services;

(d) It has already started to investigate and evaluate, all CATV services and computer centres in the Province of Quebec.

No specific regulations have yet been issued by the Board concerning private cable services. For the time being, each case must be judged individually, but a general Order on the subject will be issued by the Board within the next few months. Rates are submitted to the Board for approval. Common carriers are compelled to give details regarding the investments and the relative costs of private cable services. This obligation will be extended to all common carriers as soon as the general regulation is approved by the Board.

All the factors related to regulation have not been defined since the general Order on that subject has not yet been adopted.

This Information Provided By:

Province of Manitoba
Public Utilities Board

In Manitoba, the Public Utilities Board Act defines, in part, a public utility to be any system or equipment for the transmission of telegraph or telephone messages.[15] In the Act, the Board is empowered to exercise a general supervision of the utilities.[16] However, revisions to the Manitoba Telephone Act in 1955 provided that the Board had no direct jurisdiction to regulate the economy of the Manitoba Telephone System with respect to such items as the issue of capital, or construction expenditures.[17]

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15 Province of Manitoba. The Public Utilities Board Act S.M. 1959(2nd), c.51, Section 2(h).

16 Ibid., Section 74(1).

17 Trans-Canada Telephone System. History of Regulation and Current Regulatory Setting. Telecommission Study 1(b), March 1970.

The Board's regulatory control over the Telephone System centres on the rates and matters found in Section 77 of the Board's Act. It also has the right to technical regulation relating primarily to methods, standards and safety.

The Manitoba Telephone System does not, however, submit private line rates to the Board for approval. The Board appears to have primarily dealt with rates as they affect the general public.

This Information Provided By:

Province of Saskatchewan
Saskatchewan Telecommunications

The Saskatchewan Telecommunications Act constitutes the charter, powers and responsibilities of Sask Tel. Section 8 of the Act as amended by S.S. 1969, c. 52, sets out the powers of the corporation with respect to services, rates and special agreements. Sask Tel must publish its rates, etc., governing its services, provided that where the published rates etc., do not accommodate a particular service that is required, a special agreement may be negotiated.[18]

In practice a few of the private line services may be so well established that the rates, terms and conditions applicable thereto can be set out as a firm offering in the published schedule. However, in other private line cases the specifications vary substantially and virtually call for "custom jobs". In these cases it is necessary to determine the costs applicable to each for the purpose of negotiating special agreement rates in the competitive market.

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18 Province of Saskatchewan. The Saskatchewan Telecommunication Act., S.S. 1969, c. 52, Section 8(2), 8(3). Section 8(3) is of particular interest:

(3) Notwithstanding subsection (2), where in the opinion of the corporation the schedule of charges, rates, terms and conditions referred to in that subsection does not adequately accommodate the provision of a particular telecommunication service requested by a person, the corporation may, by itself or jointly with the owners or operators of other telecommunication systems, enter into a special agreement with such person to provide the service in accordance with charges, rates, terms or conditions at variance with or in addition to those set out or described in the schedule and the agreement shall have precedence over the schedule to the extent necessary to give effect to such agreement.

The total capital borrowing limit of Sask Tel is set out in the Act (presently $175 million). Any increase in this requires the approval of the legislature. Furthermore, all borrowings by or for Sask Tel require the approval of the Lieutenant Governor in Council. Specifically, each capital project exceeding $25,000 in cost, must, as a matter of policy, be submitted to the directors of Sask Tel for approval. The acquisition of any real property for a price exceeding $10,000 requires the approval of the Lieutenant Governor in Council. Tariff adjustments of significant consequence are, as a matter of policy, referred to the directors and responsible minister and often to Cabinet for approval. The annual report and financial statements of Sask Tel must be laid before the Legislative Assembly each year and these are reviewed by a Select Standing Committee of the Legislative Assembly.

These factors exert some influence over Sask Tel's tariff and service offerings including private line services.

This Information Provided By:

Province of Alberta
Public Utilities Board

The question of the Board's jurisdiction with respect to private line services is one that would have to be dealt with in any application which might come before the Board; or, if the Legislature deemed it necessary, there might be some expansion of the words "telegraph or telephone messages" as they appear in the definition of a public utility, to encompass private line services.[19]

This Information Provided By:

Province of British Columbia
Public Utilities Commission

The Public Utilities Act of British Columbia defines a public utility as a person who owns or operates in the Province equipment or facilities for "the conveyance or transmission of messages or communications by telephone or telegraph, where such service is offered to the public or any corporation for compensation."

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19 Province of Alberta. The Alberta Public Utilities Board Act. R.S.A. (1960), c.85, Section 2(j)(i).

20 Province of British Columbia. The Public Utilities Act. R.S.B.C. (1960), c. 323, Section 2.

Since B.C. Telephone is subject to federal regulation, the only private line services which the Commission regulates are those provided by Okanagan Telephone Company, and the general approach adopted by the Commission is the same as that for other services offered by the same company. Rates are specified by tariff and are the same for all subscribers who request service under substantially the same terms and conditions.

There is no attempt to segregate the investment which applied to private line service as distinct from the other services offered, but the telephone utility as a whole is regulated on the basis of a fair rate of return on original cost rate base. The Telephone Company submits capital budgets and applies for Certificates of Public Convenience and Necessity for major additions if such major additions substantially alter the service area of the Company or if, as a result of review of the capital budget, the Commission deems such application (and consequent advertisement) to be required in the public interest. The Telephone Company also submits for prior approval new service offerings.

APPENDIX B

Information Relative to the Significance of Private Line Service Provided by:

TRANS CANADA TELEPHONE SYSTEM

CANADIAN NATIONAL/CANADIAN PACIFIC
TELECOMMUNICATIONS

MESSAGE TOLL AND PRIVATE LINE CIRCUITS (1)

TRANS-CANADA TELEPHONE SYSTEM MAJOR ROUTES

See Note Below

INTER-PROVINCIAL

	B.C. TO ALTA	% OF TOTAL	ALTA TO SASK	% OF TOTAL	SASK TO MAN	% OF TOTAL	MAN TO ONT	% OF TOTAL	ONT TO QUE	% OF TOTAL	QUE TO N.B.	% OF TOTAL	N.B. TO N.S.	% OF TOTAL
1967														
Message Toll & TWX	355	93	565	95	530	94	499	92	964	77	372	93	322	80
(2)P/L Voice & TTY	4	1	3	1	3	1	3	1	150	12	4	1	6	2
Program	24	6	26	4	28	5	30	5	34	3	20	5	25	6
Defence	-	-	-	-	-	-	14	2	100	8	3	1	47	12
Total Voice Equivalent	383	100	594	100	561	100	546	100	1248	100	399	100	400	100
Total 1-way Video	4		5		4		4		4		4		3	
1968														
Message Toll & TWX	433	92	686	94	631	94	630	90	1238	79	422	87	372	82
(2)P/L Voice & TTY	4	1	4	1	4	1	5	1	167	11	6	1	8	2
Program	24	5	26	4	28	4	30	4	34	2	20	4	25	5
Defence	9	2	10	1	10	1	35	5	121	8	34	8	49	11
Total Voice Equivalent	470	100	726	100	673	100	700	100	1560	100	482	100	454	100
Total 1-way Video	4		5		4		4		4		4		3	
1969														
Message Toll & TWX	517	92	797	94	770	94	791	90	1484	71	486	80	441	84
(2)P/L Voice & TTY	5	1	6	1	7	1	8	1	179	9	5	1	8	2
Program	24	4	26	3	28	3	36	4	34	2	20	3	24	5
Defence	18	3	21	2	17	2	48	5	384	18	98	16	49	9
Total Voice Equivalent	564	100	848	100	822	100	883	100	2081	100	609	100	522	100
Total 1-way Video	4		5		4		4		4		4		3	

(1) Does not include circuits leased to other carriers
(2) These figures represent the voice equivalent for teletype circuits.

NOTE: Records for Private Line Voice and Teletype exclusive of Foreign Exchange, Tie Trunks, and Off-Premise Extensions were available for 1969 only. Using these current data as a basis, appropriate statistics were developed for 1967 and 1968.

MESSAGE TOLL AND PRIVATE LINE CIRCUITS (1)

TRANS-CANADA TELEPHONE SYSTEM MAJOR ROUTES

See Note Below

CANADA - U.S.A.

	B.C. TO USA	% OF TOTAL	ALTA TO USA	% OF TOTAL	SASK TO USA	% OF TOTAL	MAN TO USA	% OF TOTAL	ONT TO USA	% OF TOTAL	QUE TO USA	% OF TOTAL	N.B. TO USA	% OF TOTAL
1967														
Message Toll & TWX	258	93	53	48	-	-	166	93	987	86	1083	92	102	39
(2)P/L Voice & TTY	9	3	1	1	-	-	3	2	144	11	73	5	5	2
Program	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Defence	11	4	57	51	-	-	9	5	40	3	42	3	157	59
Total Voice Equivalent	278	100	111	100	-	-	178	100	1171	100	1198	100	264	100
Total 1-way Video	-		-		-		-		4		-		-	
1968														
Message Toll & TWX	322	57	71	48	-	-	245	79	1190	77	1157	83	100	29
(2)P/L Voice & TTY	9	2	1	1	-	-	3	2	160	9	79	4	5	2
Program	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Defence	236	41	75	51	-	-	59	19	214	14	184	13	238	69
Total Voice Equivalent	567	100	147	100	-	-	307	100	1564	100	1420	100	343	100
Total 1-way Video	-		-		-		-		4		-		-	
1969														
Message Toll & TWX	357	62	107	34	-	-	263	79	1562	80	1187	75	111	47
(2)P/L Voice & TTY	13	2	2	1	-	-	8	2	178	8	87	3	6	3
Program	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Defence	206	36	203	65	86	100	60	19	222	12	348	22	120	50
Total Voice Equivalent	576	100	312	100	86	100	331	100	1962	100	1622	100	237	100
Total 1-way Video	-			-	-		-		4		-		-	

(1) Does not include circuits leased to other carriers
(2) These figures represent the voice equivalent for teletype circuits.

NOTE: Records for Private Line Voice and Teletype exclusive of Foreign Exchange, Tie Trunks, and Off-Premise Extensions were available for 1969 only. Using these current data as a basis, appropriate statistics were developed for 1967 and 1968.

CIRCUIT MILES - TRANS-CANADA TELEPHONE SYSTEM

See Note Below

	1967		1968		1969	
	Miles	% of Total	Miles	% of Total	Miles	% of Total
Message Toll (incl. TWX)	4,730,000	90%	5,560,000	86%	7,020,000	86%
Private Line	506,000	10%	907,000	14%	1,125,000	14%
Totals	5,236,000		6,467,000		8,145,000	

Growth in:	1967 - 1968	1968 - 1969
Message Toll	17%	26%
Private Line	79%	24%
Totals	24%	26%

ORIGINATED REVENUES - TRANS-CANADA TELEPHONE SYSTEM

See Note Below

Year	Private Services	Total Operating Revenue - TCTS	% Private Services
1967	$ 45,118,000	$ 1,046,832,000	4.30%
1968	$ 51,797,000	$ 1,138,394,000	4.55%
1969	$ 58,341,000	$ 1,268,277,000	4.60%
Growth 1967 - 1968	15%	9%	
Growth 1968 - 1969	13%	11%	

NOTE: Telephone records do not distinguish between exchange-connected circuits (Foreign Exchange and Tie Trunks) and non-exchange-connected voice-grade private lines. The former were extracted by an estimating process based on current available data.

PRIVATE LINE STATISTICS

CANADIAN NATIONAL/CANADIAN PACIFIC TELECOMMUNICATIONS

The position of CN/CP in respect of revenue derived from non-regulated services in relation to that derived from regulated services clearly points up the importance to our operations of the service furnished by us within the present non-regulated environment. The following illustrates this:

JOINT CN/CP REVENUES FROM NON-REGULATED SERVICES YEAR 1969

Private wire, Telex, Radio and Television program services	$ 67,600,000
Broadband Exchange Service	$ 1,000,000
TOTAL:	$ 68,600,000

On the basis of these figures CN derives 75.6% and CP 81.7% of their total revenues from present non-regulated services. It must be pointed out that the extension of regulation to services not now regulated will affect in excess of 75% of CN/CP's business while it is unlikely to have an impact on more than the 5% of the Telephone Companies total revenues derived by them from this non-regulated source.

Our forecast of revenue growth of the services bulked under the general heading of Private Line Services over the next five years, with the exception of Broadband Exchange Service, where the present estimated high growth rate may be expected to decline percentagewise as the network expands in subscribers, is as follows:

Telex 14%-16% per annum

Private Wire Service 5%-6% per annum

Broadband Exchange Service 40%-50% per annum (for next two years when the growth rate is expected to decline significantly).

At the same time, however, as we forecast this growth rate in the present non-regulated services, we must also forecast a decrease in usage of the regulated public message service by a percentage rate of 3%-5% per annum.

Regulation of monopoly public services needs to impose adequate constraints to insure that the public interest is protected as well as to maintain the viability of this sector of the enterprise. Competitive services should be treated differently. In the latter case, regulation must be sufficiently broad to promote effective and fair competition. On the other hand, adequate regulatory power must be available to cover the entire spectrum of services so as to prevent the economic strength derived from protected markets in the monopoly field from being used by carriers to engage in unfair or destructive practices vis-a-vis other carriers in the competitive field.

Separation of costs in respect of each service offering would, in our view, be a necessary corollary to regulation of such individual service offering. Moreover, from a Telecommission or regulatory viewpoint, it could well be desirable to separate costs associated with monopolistic and competitive services to assure against cross-subsidization.

A very strong marketing effort is directed to those services now not regulated. It is supported by a strong well-directed sales organization. This is a joint CN/CP effort. The CN, however, are also directing substantial marketing and sales effort to the development of public telephone services furnished by them and which, of course, are now regulated. Insofar as the regulated public message service is concerned, experience over a number of years has shown that no amount of marketing and sales development work will have any appreciable effect on the volume, neither will advertising, irrespective of media used, bring about any significant change in the progressive decline in use of this medium of communications. Hence, the marketing and sales effort expended on the sales development of the public message (telegram) is minimal. It does, however, form part of the function of our joint CN/CP sales organization.

APPENDIX C

Submissions of Relevance to this Study

Canadian Association of Broadcasters
(This Submission initially prepared for Telecommission Study 1(d))

Canadian Electrical Association

Canadian Cable Television Association

Canadian Manufacturers' Association

Telesat Canada

Note: Requests for details of the information contained in the above mentioned submissions should be directed to the respective organizations.

TELECOMMISSION

Study 8(b)(i)

Study of Interconnection of Private Telecommunications Systems with the Systems of the Telecommunication Common Carriers

The Department of Communications

REPORT

TO

DEPARTMENT OF COMMUNICATIONS, TELECOMMISSION

BY

ACRES INTERTEL LIMITED

STUDY OF INTERCONNECTION OF PRIVATE
TELECOMMUNICATION SYSTEMS WITH THE
SYSTEMS OF THE TELECOMMUNICATION
COMMON CARRIERS

TELECOMMISSION SECTION 8 (b)(i)

August 1970

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ABBREVIATIONS

AE	Automatic Electric (Canada) Limited
AGT	Alberta Government Telephones
Alcan	Alcan Aluminium Limited
BC Tel	British Columbia Telephone Company
CBC	Canadian Broadcasting Corporation
CEA	Canadian Electrical Association
CGE	Canadian General Electric Company Ltd.
CN-CP	Canadian National-Canadian Pacific Telecommunications
CNR	Canadian National Railway Company
CNT	Canadian National Telecommunications
COTC	Canadian Overseas Telecommunication Corporation
DND	Department of National Defence
DOC	Department of Communications
DOT	Department of Transport
IBM	IBM Canada Ltd.
PBX	Private Branch Exchange
PGE	Pacific Great Eastern Railway Company
RCMP	Royal Canadian Mounted Police
RCC	Restricted Common Carrier
TCTS	Trans-Canada Telephone System
UHF	Ultra High Frequency
VHF	Very High Frequency

SECTION 1

SCOPE OF WORK

1.1 This report is the result of the study carried out by Acres InterTel Limited under a contract with the Department of Communications, Telecommission, Section 8 (b)(i), described as:

"the interconnection of private telecommunication systems with the systems of the telecommunication common carriers".

This is elaborated to mean:

a) the interconnection of private and entrepreneurial systems with the switched telephone network;

b) the interconnection situations that could exist for systems comprised of user leased,or user leased and user owned facilities; and

c) the interconnection of private systems to each other.

1.2 For the purposes of the study, private telecommunication systems have been defined as:

a) private systems that are totally "user owned";

b) private systems that are totally "user leased" from one or more telecommunications common carriers or systems comprised of both leased and owned facilities;

c) entrepreneurial systems, either owned or leased, which offer telecommunication services for hire.

1.3 The objectives of the study are classified under the following two major categories:

a) examination of the interconnection situation which currently exists and the economic, commercial and/or technical factors which contribute to it. (i.e. existing interconnection policies of the Federal and Provincial departments concerning telecommunications, common carriers and private system users).

b) examination of the interconnection situation that could arise in the future, in terms of trends and developments; the necessity for the formulation of suitable public policy on interconnection to safeguard public interest; and the impact of such policies on common carriers and private system users.

1.4 The types of interconnections discussed in the study are:

a) interconnection of a private system or equipment such as a PBX to the common carrier switched telephone network;

b) interconnection of a user owned system with that leased from a carrier;

c) interconnection between several networks leased from different carriers by the same user.

d) interconnection between two or more leased networks belonging to different users;

e) interconnection of user owned systems to each other.

NOTE:

1. The scope of the study does not include examination of the Telex network. The interconnection with regard to data circuits as discussed in the text does not in any way reflect the problems that may be associated with the Telex network.

2. The study also examines broadband and video networks, where applicable.

3. The provision for specific RF channels to meet user needs (e.g. TV) is not considered as interconnection.

SECTION 2

INTRODUCTION

2.1 GENERAL

Canada's primary telecommunication capability is provided by the telephone companies and railway companies that form the family of telecommunication carriers.

In addition to the telecommunication networks for service to the public, there is a growing telecommunication capability under private ownership. In most cases these telecommunication systems are used to serve special users' needs and do not form part of the public telecommunication network.

In general, most systems offering public service are interconnected to provide a nation-wide telecommunications network.

Such interconnection does not exist in the case of private systems which are generally isolated from the nation-wide public system and from each other. It is the subject of this report to study the problems associated with the interconnection of private systems with other private and public systems.

2.2 DEFINITIONS

The definitions in this section apply only to this report and were derived to give clear meaning to terms which, though in general use, lack common understanding.

Carriers

Common carriers or entrepreneurs offering telecommunication

service for public use, for hire, or for both.

Common Carrier/Telecommunication Carrier

A company chartered to provide the public with telegraph and/or telephone service through a switched network.

NOTE: This definition covers only the basic function of the common carrier and does not reflect a limitation of its operations. All the major common carriers use their transmission systems to carry other forms of traffic.

The purpose of common carrier systems is to handle traffic for the general public. Except for administration and maintenance they do not originate their own traffic.

Restricted Common Carrier

An organization offering a specialized service to the public such as a radio paging service or land mobile service.

Private System

A communications system designed to meet the special needs of certain users which does not provide service to the general public.

A private system may be either user owned, user leased from carriers or a combination of both.

A private system originates and carries its own traffic. In addition the system may offer specific services to the user, which may not be available from the common carriers via public networks.

Entrepreneurial System

A commercial system operated for the purpose of providing telecommunication facilities to any interested party (private user or common carrier). An entrepreneurial system is sometimes called

"Carrier's Carrier".

Interconnection

The connection of a given private system to that controlled by a different operator or user such that the information carried over one system is transferred to the other.

2.3 SYSTEMS CLASSIFICATION

All systems investigated and considered for the study are classified under the following headings, as defined above:

a) Common Carrier Systems

b) Private Systems

c) Entrepreneurial Systems

This system classification is governed by operational use rather than ownership; thus leased networks operated by private users are classified under private systems, although the facilities may be owned by common carriers.

SECTION 3

EXISTING TELECOMMUNICATION SYSTEMS IN CANADA

3.1 COMMON CARRIER SYSTEMS

3.1.1 Review of Domestic Communications Systems

The telecommunications systems belonging to the telephone and railway companies are integrated to provide a nationwide public telephone service.

The concept of an integrated telephone system is a matter of fundamental importance. The public demands instant, reliable and efficient telephone service at reasonable rates between any two subscribers in the country. On the basis of existing technology such a requirement can only be met by:

a) having an integrated operational system through close and stable relationships between the telephone companies,

b) having a switched telephone network connecting all terminals reliably and economically.

While coordination and cooperation between various telecommunication carriers control system optimization (i.e. coordinated planning to achieve efficient service with minimum redundancy), the system integrity, which governs the quality and the reliability of the telephone service, requires control over the quality of inputs into the network. Therefore, in considering the question of interconnection between private systems and the public switched telephone network,

the technical compatibility of the interface and the maintenance and operation of the private systems which affect system integrity, have to be examined. Technical considerations alone cannot ensure that the quality and reliability of the switched telephone network will be maintained.

3.1.2 Common Carrier Classifications

The Canadian common carriers can be divided into the following groups:

a) Trans-Canada Telephone System (TCTS)

Formed by the major telephone companies in Canada with the object of developing and maintaining a coast to coast, long-distance, telephone network.

b) Independent Telephone Companies

Over 1,600 independent telephone companies providing public telecommunication service in the areas they serve.

c) The Railway Telecommunication Systems

3.1.3 Telephone Company Systems

Members of the Trans-Canada Telephone System work together on a nationwide basis. Their systems are interconnected to provide a complete network capable of carrying a diversity of communication traffic including public telephone traffic and defence traffic. The Canadian Overseas Telecommunication Corporation (COTC) is an associate member of TCTS and is responsible for international (overseas) traffic. COTC and TCTS systems are interconnected to provide routes

for overseas telephone calls.

The independent telephone companies are interconnected with the TCTS telephone network to form a single large integrated public telephone service network. This integration is achieved through inter-company agreements within the Telephone Association of Canada and through Federal and Provincial Acts. By virtue of these acts the public switched telephone service of the common carriers is protected against destructive competition in their respective areas of operation.

Interconnection for services other than the telephone is provided in some cases. The telephone companies follow no set rules in such instances and interconnection is generally made on the basis of mutual agreement.

3.1.4 Railway Telecommunications Systems

CN-CP Telecommunications operate under Federal Charter and, besides their extensive private line business, provide

a) telegraph services from coast to coast

b) public telephone service (CN) in parts of Newfoundland, North West Territories and Yukon Territory

c) telecommunication services for railway use (analogous to a private system)

For all public telephone services as well as for the railway operation, facilities for interconnection with the public switched network are available. Any other interconnection requirements are met by mutual agreement.

The PGE, under British Columbia Provincial Charter, enjoys

common carrier status but does not offer telephone service facilities to the general public on the same basis as telephone companies. Apart from the specific circuits used for railway communications, the PGE system is available for hire to various users in the area as private line service. PGE's circuits serving the railway operational requirements are interconnected with the public switched telephone network of the telephone companies under the provision of the Public Utility Act of British Columbia.

3.1.5 Private Line Services of Common Carriers

In addition to their role as public utilities the common carriers also offer private line service for hire (an entrepreneurial role) to meet specific needs of users. These private lines, in a majority of cases, share the same equipment and terminal facilities as the public system.

Since private lines have little influence on the integrity of the public switched telephone network a monopoly situation, as in the public service case, does not exist. The common carriers are free to compete with one another for their share of business, but also have agreements for mutual support (piece-out arrangements) in cases where facilities of one carrier can supplement those of another carrier. However, Telephone companies, by virtue of their interconnection forming a nationwide switched network are at an advantage in offering certain service packages and tend to exploit the situation and thereby prevent competition in those offerings.

TCTS members claim that their private line business exposed to competition accounts for about 4 percent of their total business, whereas the CN-CP figure is over 75 percent. With the growth of teleprocessing and other special requirements it is estimated that the rate of growth of private line services in the non-voice categories will be high -- possibly much higher than that of the public switched telephone service in years to come. The study of interconnection problems, which constitutes one of the many factors affecting this growth, and the development of suitable solutions will certainly influence the future pattern of private line services.

As the situation now stands, private line circuits belonging to common carriers other than those of TCTS members (i.e. railway company facilities) do not enjoy the same privilege of interconnection either with the switched telephone network or with each other. Wherever interconnections do exist they are made on the basis of specific negotiations between the parties concerned.

3.2 PRIVATE SYSTEMS

In addition to the common carrier systems a large number of private communication systems exist in Canada. The growth of such systems has been due to the specialized nature of the users' requirements which could not easily be met by the services of the common carriers. The reasons which led users to the establishment of private systems can usually be found in the areas of : the specifically required technical characteristics different from those of the common carrier systems, the desire for electrical systems security (preventing any

form of access or interference from outside sources), and the economics of the situation. The main economical problem is usually that the user is faced with a divergence between the actual costs of a system supplied by himself and meeting his own specific requirements, and the corresponding charges of a common carrier, where the carrier's charges do not necessarily reflect the direct costs of the specific facilities but are related to the impact of the required systems addition to his overall operation.

The difference in costs to the user may then seem to favour the acquisition of a private system, although the advantage may be entirely to the benefit of the private user at the expense to the public at large which may have to bear hidden costs or otherwise be better served by a different solution.

Private systems are either totally user owned, or leased from carrier organizations, or a combination of both. Serving the user's specific internal purposes they may not require any interconnection with the public switched network. On the other hand there may be a primary or secondary requirement for access to the outside world in which case an interconnection requirement arises. Since this report is concerned with problems of interconnection only, the question of justification and economic basis of private systems themselves will be dealt with only to the extent to which interconnection problems are involved.

A broad classification of the various types of private systems which either have interconnection or may have requirements for

interconnection is as follows:

a) Federal Government Systems (DOT, RCMP and DND)

b) Public Utility Systems (Ontario Hydro, Hydro-Quebec, BC Hydro)

c) Public Service Systems (police, fire and hospital services)

d) Broadcast Systems (TV and radio networks)

e) Industrial Inter-Office Systems

f) Private Utility Systems (oil and gas company systems)

g) In-house Systems (hotel PBX)

h) Data Transmission Systems (computer service company networks)

i) Resource Development Company Systems (mining and lumber companies)

j) Paging and Land Mobile Systems.

3.3 ENTREPRENEURIAL SYSTEMS

Strictly speaking no major trunk communication system, built for purely entrepreneurial purposes, now exists in Canada. One system of this type, the NORCOM system in the Kenora area, was sold to Bell Canada in 1968. Some functional characteristics of this system are given in Appendix B.

Restricted Common Carrier systems (RCC) providing radio paging and radio land mobile facilities on a hire basis also fall under the category of entrepreneurial systems.

To a large extent the railway systems play an entrepreneurial role in most of the areas they serve by offering various private wire services to private users.

The telephone companies also utilize their facilities, over and above those of the public switched network, for renting to private users. There is competition for purely private line business (private lines without interconnection to the public switched network) between the railway and telephone companies in areas where both facilities are available, but as mentioned earlier, there are also agreements for mutual support in areas where one carrier's facilities can supplement those of another carrier.

SECTION 4

CURRENT INTERCONNECTION SITUATION

4.1 GENERAL

To ascertain the current interconnection situation in Canada a cross-section of private users, common carriers and manufacturers of telecommunication equipment were interviewed. Summaries of these discussions are given under Appendices A - C. Through these investigations it has been possible to identify the extent of interconnection, isolate the problem areas and carry out a qualitative analysis of the prevailing interconnection situation in the country. However, as information relating to actual costs, revenues, traffic planning, and details of negotiations and agreements were not obtainable from the organizations interviewed, a quantitative analysis of the commercial and economic issues, and their dependence on policies and regulatory action, remained outside the scope of this study.

4.2 PRIVATE SYSTEM USERS

Communication networks operated by the following organizations are typical of private communication systems in Canada:

a) Alcan Aluminium Limited

b) Canadian Association of Chiefs of Police

c) British Columbia Hydro and Power Authority

d) Canadian broadcasters

e) Canadian General Electric Company

f) Department of Transport

g) Ford Motor Company of Canada

h) Hotel Association of Canada

i) Hydro-Quebec

j) IBM Canada Ltd.

k) Interprovincial Pipe Line Company

l) Ontario Hydro

m) Trans Mountain Oil Pipe Line Company

n) Westcoast Transmission Company Limited

o) Resource development companies

p) Others - users of radio land mobile service and radio paging service

The above systems were studied from an interconnection point of view and notes identifying the cases where interconnections are either in existence or have run into difficulties are given in Sections 4.2.1 through 4.2.16.

4.2.1 Alcan Aluminium Limited

Alcan operates an extensive private, national and international network in which all circuits and most equipment in Canada are leased through Bell Canada. Overseas circuits are provided by COTC.

The system comprises a control centre in Montreal with data, record message and voice capabilities.

Interconnection problems are not encountered because of the totally leased, private nature of the system, intended solely for operational use of the company.

4.2.2 Canadian Association of Chiefs of Police

The report contained in full in Appendix A to this report was provided to the Telecommission by the Canadian Association of Chiefs of Police. The underlined portions refer to the subject of interconnection.

4.2.3 British Columbia Hydro and Power Authority

The operational philosophy of BC Hydro is similar to that of Hydro-Quebec. Interconnection between the BC Hydro microwave and power line communication network and that of the common carrier providing public service is not favoured. Our investigations did not reveal the existence of any major interconnection.

Interconnection (private to private) with the Bonneville Power Administration System is made at Ingledow Substation.

4.2.4 Canadian Broadcasters

Canadian broadcasters make extensive use of common carrier wideband private wire facilities for carrying signals from studio to transmitter sites and for network distribution.

Many studio-to-common-carrier terminal links are user owned and interconnection is effected between the user owned and the user leased systems.

The wideband network is usually "custom made" to satisfy the users specifications and requirements, thus interconnection difficulties are not experienced.

4.2.5 Canadian General Electric Company

CGE does not operate a private system requiring interconnection with the public switched telephone network. However, the company offers a time shared computer service to subscribers with connection to computers by private lines leased from common carriers.

4.2.6 Department of Transport

DOT has interconnection facilities between its leased circuits and the public switched telephone network (private to common carrier) for the following purposes:

a) Air Traffic Control

b) Marine Traffic Control

c) Air to Ground Communications

d) Ship to Shore Communications

In the latter case the role of DOT is similar to that of a common carrier and public service is offered when required.

On a private to private basis there are also interconnections between DOT and the leased circuits of the Canadian Switched Network (DND counterpart of the U.S. AUTOVON) and the CP Air system. Messages from CP aircraft are routed through DOT ground radio stations to CP air control.

To achieve economy and higher operational efficiency, DOT is undertaking a program to monitor 287 lighthouses from central locations. However, communication to most of these locations does not exist and DOT is proposing to install its own network from these points to meet common carrier facilities and the public switched network. The telephone companies have not yet responded to the DOT request for provision of interconnections on this basis after more than a year of negotiations.

For pollution control in Lake Erie DOT has proposed an air patrol using VHF equipment and a frequency synthesizer in one of its

aircraft. The object is to detect and report oil patches and probable offenders as and when necessary. To achieve an operational air to ground system, DOT needs interconnection facilities with the switched public network VHF mobile base stations located along Lake Erie. The Telephone Company has been apprcached on this matter but no satisfactory response has yet been received after eight months.

4.2.7 Ford Motor Company of Canada

Ford Motor Company, like many other large corporations, has an extensive private communications network.

The system includes user owned intercommunication and VHF/UHF mobile radio facilities, and a network of circuits leased from Bell Canada and CN-CP Telecommunications.

The intercommunications facilities in the plant and the main office which are separated by about half a mile are interconnected by a cable leased from Bell Canada.

No interconnection exists between the Ford communication circuits and the public and there is no interconnection of circuits leased from the telephone company and those leased from the railway common carriers.

4.2.8 Hotel Association of Canada

The Hotel Association of Canada is one of the major critics of telephone companies who, in hotelmen's opinion, due to their monopolistic position compel hotels to accept unreasonable contractual agreements for telephone service provided in hotel rooms.

The major areas of complaint are summarized as follows:

a) Telephone companies charge a higher rate for extension service in hotel rooms than in private residences. Hotels feel that these extension telephones in guest rooms are definitely residential; therefore telephone companies are being indirectly subsidized by hotels amounting to undue discrimination against hotels.*

b) There appears to be inconsistency in the contracts made between hotels and the telephone companies.

c) Hotels pay rental charges on the same PBX with no suggestion from telephone companies about replacement by more modern equipment.

d) Hotels require custom tailored telephone installations to meet their needs. However, the charges imposed by the telephone companies often discourage

* Hotel guests normally pay between $0.15 and $0.50 <u>on their hotel bill</u> for each call made from telephones installed in guest rooms.

this. The hotelmen reason that they should have a choice of either purchase or lease from any reliable supplier (including the telephone company) with interconnection privileges to the public network in order to provide better service to their guests and to reduce their own operating costs.

4.2.9 Hydro-Quebec

Hydro-Quebec operates its own telecommunications system which includes microwave as well as power line carrier networks. The microwave network which is used mainly for power system operation purposes, also carries administrative circuits. The P.L.C. system is used exclusively for power system operation.

In general, no interconnection facilities exist between the Hydro-Quebec communication system and the public switched telephone network. Such interconnections are not favoured as they lead to a reduction in system security and reliability.

To allow access to the public telephone system, most of the power stations and sub-stations also have public telephone facilities. As a special case, in the Rouyn area, a few Hydro-Quebec circuits have been made available (free-of-charge) to Northern Telephone Limited to extend the public telephone service to Hydro-Quebec generating stations and sub-stations in this region. In addition, during the construction period of the Manicouagan project, Hydro-Quebec is leasing approximately 40 voice circuits to Quebec Telephone in order to make available public telephone service, at the construction sites. Some circuits may be retained (free-of-charge) to provide public telephone service to the new hydro stations when operational.

The following intercompany interconnections (private-to-private) exist:

a) with New Brunswick Electric Power Commission via power line carrier.

b) with Alcan via powerline carrier and their Saguenay PBX.

c) with Ontario Hydro at eight locations (Section 4.2.12).

In view of its operational philosophy, Hydro-Quebec has no demand either for leased communication channels or interconnection facilities via the common carrier operated public switched telephone network for power system operation, protection and control purposes.

4.2.10 IBM Canada Ltd.

IBM Canada has an extensive leased communication network interconnecting branch offices throughout Canada for administrative purposes and data transmission. IBM's 23 Datacentres are also linked by common carrier telecommunication facilities. This system makes a substantial variety of machines, programs and services available to users across the country.

The IBM telecommunication networks are comprised of circuits provided by telephone companies and CN-CP Telecommunications. The IBM Datacentre offers a broad range of remote data processing services. The customer, through a terminal in his own office, can communicate directly with a Datacentre computer via a public or private telecommunication link and make use of a data processing service without leaving his office. Flexibility of access to many data processing services from a single terminal, access to a given data processing centre from many points, or alternate routing capability may be reduced from the users point of view by the current interconnection practices.

IBM stated that interconnection, by using privately-owned equipment, of telecommunication carriers' leased line services with switched services, and interconnection between these services and privately-owned telecommunication facilities would be helpful in encouraging expansion and new developments of data processing applications and services. Users of data processing would benefit from the expansion of applications and economies which would result.

IBM recognizes the importance of maintaining the integrity of the telecommunication carrier's system. They believe, however, that a more liberal policy towards interconnection should be considered and that suitable technical specifications could be determined to permit this.

4.2.11 Interprovincial Pipe Line Company

Interprovincial Pipe Line operates a long but simple communication system composed entirely of leased circuits. All leased circuits are arranged through Alberta Government Telephones and the arrangement is considered satisfactory.

Interconnection between the pipeline leased system and the public network is considered detrimental to pipeline operation and no such facility has been requested. However, all pipeline stations are served by the public telephone system. A VHF mobile system is used for pipeline maintenance but it is not interconnected with the leased network.

4.2.12 Ontario Hydro

Ontario Hydro operates a large communication network which includes a privately-owned microwave system, some privately-owned powerline carrier channels and also an administrative telephone system leased from Bell Canada and other connecting companies.

The service and interconnection agreement with Bell Canada which was recorded under DOT Approval R-1567, 22 February 1968 and filed with the Canadian Transport Commission records office, allows the interconnection of certain facilities of Ontario Hydro with the facilities of the telephone company including the public switched telephone network via PBXs located on Ontario Hydro premises. The use of the leased system and interconnections is limited to Ontario Hydro employees only for power commission business.

Points of interconnection (private to private) with other utilities are:

a)	Manitoba	-	Seven Sisters Generating Station	
b)	Quebec	-	Beauharnois	Bryson
			Masson	Rouyn
			Val Tetreau	Kipawa
			Paugan	Rapide des Iles
c)	U.S.A	-	Niagara Falls, N.Y.	
			Lewiston, N.Y.	
			Massena , N.Y.	
			Detroit, Mich.	
			Marysville, Mich.	
			St. Clair, Mich.	

These interconnections with the switched public network are permitted by the telephone company in circumstances where such interconnections are either vital for conducting power company business

or for emergency situations involving safety of life or property.

In every case of interconnection, Ontario Hydro is responsible for taking all restrictive measures to prevent misuse of such interconnections.

4.2.13 Trans Mountain Oil Pipe Line Company

The Trans Mountain Oil Pipe Line Company communications facilities include for operational purposes the following facilities:

a) A high grade voice circuit consisting of a microwave channel leased from CN Telecommunications which follows approximately the route of the pipe line from end to end.

b) A private wire teleprinter system leased from B. C. Telephone Company. This system interconnects in Canada located facilities with U.S. located ones.

c) Telex facilities to the major pump stations, administrative offices and central warehouse facilities.

d) Leased private wire voice grade, narrow band and telegraph circuits (D.C. loop) for station remote control and telemetering purposes.

The facilities required for operational purposes are supplemented by:

a) A VHF radio telephone system leased from CN Telecommunications. This system can be patched-into the microwave channel via repeater stations from the base station and all the mobile stations. This VHF radio system provides total voice communications from any point along the pipe line route to any other given point along its route. The circuit is primarily used for maintenance purposes.

b) Public Switched Telephone System to all pump stations, administration offices and warehouse facilities.

Interconnection of leased network facilities with public switched telephone system is not considered necessary for pipe line operation and the Company has never negotiated with the carriers for such facilities.

4.2.14 Westcoast Transmission Company Limited

Westcoast operates an extensive landline and microwave network of circuits leased from PGE and CN Telecommunications with major exchanges leased from BC Tel. In addition, West Coast also operates a large VHF mobile system for pipeline maintenance.

Details of interconnections are contained in Appendix A.

4.2.15 Resource Development Companies

Resource development companies experience interconnection problems, particularly when operating in remote northerly areas where the need for communications and access to the common carrier systems is considered vital to the community.

As long as the requirements are small, say, only one or two voice channels, the telephone companies usually enter into interconnection agreements which allow users to own and operate equipment at the users end. A number of HF circuits and land mobile VHF circuits are operated in this fashion. However, complications arise when the communication needs call for more than this number of voice channels and dictate the use of wideband equipment.

When the development area is located far away from the available common carrier route economic considerations usually make it difficult for the operating company to enter into an agreement with the common carrier for the extension of the common carrier telecommunications services to the region under consideration. In a situation like this the company is forced to provide its own system to the point where common carrier facilities begin.

Difficulties are experienced when interconnection aimed at extending public service to company personnel in the remote area is requested from the common carrier. Some common carriers refuse to provide the interconnection and insist on providing an entire system at a price which is usually too high from the point of view of

the company. Others are prepared to enter into some form of barter agreeement with the operating company.

Historically situations of this kind have led to the formation of chartered telephone companies which were then fully integrated into the public network (La Compagnie Telephone Ungava is an example). In other cases negotiations are aimed to find a compromise between the costs the user anticipates for a system satisfying his own internal needs and those arising from the interconnection requirement. As mentioned earlier these latter costs are not directly related to the actual facility costs but reflect the telephone company's assessment of the requirement in the light of overall investment, revenue, operational implications and company planning.

4.2.16 Others - Users of Radio Land Mobile Service and Radio Paging Service

a) Radio Land Mobile Service

Over the last decade there has been an increasing demand for radio land mobile service from a broad group of private users comprising industrial, commercial and public service organizations. In the majority of cases, the requirements call for a base station and a few mobile units for each installation. Common carriers offer a similar public commercial service with access to the public telephone network but the system offered is usually more sophisticated than is actually needed and is considered quite expensive. It is understood that the Bell Canada rate for this land mobile service is $46.00 per month for each unit when the mobile is leased from Bell Canada and $16.00 per month if the mobile unit is Bell Canada approved but customer owned.

A number of users of radio mobile systems have expressed the need for interconnection facilities with the public switched telephone network for improvement of their operations. Of these, the interconnection requirements of the hospital services and fire fighting services are of special interest. These organizations provide public

emergency services and operate extensive radio mobile systems. Telephone company attitudes toward the provision of interconnection facilities to these public service organizations do not appear to be uniform. Independent telephone companies seem to have a more flexible policy than do TCTS members and cases exist where interconnection requirements have been met by independent common carriers.

b) Radio Paging Service

Radio paging permits an office or department of a company to maintain contact with its representatives or sales force throughout the working day and, in fact, after hours, if necessary.

The system is essentially one-way in which the message is transmitted to a paging receiver carried by the person to be contacted. Each call is coded so that it is received only by the person for whom it is intended.

The service is applicable to all areas of endeavour - construction, maintenance, security, medical, sales, etc., and the improvement in operating efficiency through its application has promoted its use many fold over the last few years.

Two types are in common use - tone paging and one-way voice paging. Voice paging is becoming more popular because it enables the person paged to receive specific instructions regarding his immediate action.

Bell Canada offers wide area tone paging (Bell Boy "35") in Montreal, Toronto and Ottawa. The rental for the paging units is $18.00 per month. The system is integrated with the public telephone exchange and the subscriber can access the paging transmitter via a normal telephone handset. During our investigation we did not find any organization using a purely private, wide area, paging facility.

4.3 COMMON CARRIERS

The following were successfully contacted for contributions:

a) CN-CP Telecommunications

b) Trans-Canada Telephone System

c) Pacific Great Eastern Railway

d) La Compagnie Telephone Ungava
Labrador Telephone Company

Comments and opinions are summarized in Section 4.3.1 through 4.3.4 inclusive and in greater detail in Appendix B.

4.3.1 CN-CP Telecommunications

CN-CP will arrange the interconnection of a user owned system and its own network. under the following conditions:

a) Technical compatibility of the private system with the CN-CP network at the point of interconnection.

b) The carrier has the absolute right to disconnect a private interconnected circuit if, in CN-CP opinion, the private network introduces a degrading factor into the carrier's system.

c) The carrier will not guarantee the performance of the private network beyond the point of interconnection.

CN-CP feels that subscribers to Broadband service, which has no monopolistic characteristics should be permitted to interconnect with the local telephone switched system. This view is supported by the reasoning that the local telephone distribution system is a natural monopoly using much of the public domain. Therefore, users should have the right to access Broadband through the local telephone switched service, at least for digital transmission purposes.

4.3.2 Trans-Canada Telephone System

The policies and opinions of the TCTS were solicited in a form of questionnaire covering the various aspects of the interconnection situation. This is reproduced in Appendix B together with the TCTS response. Because policies are individual to particular companies and vary across the country some questions remain unanswered.

In summary TCTS policy is aimed towards ensuring desired overall integrity of the public telephone network; the interconnection between private communication systems and the public switched telephone network is not generally allowed unless there are overriding reasons stemming from economics, public interest or public safety.

4.3.3 PGE

PGE enjoys common carrier status but does not provide public telephone service. With the exception of circuits used for railway communications the PGE system provides private line service to users.

PGE has adopted a liberal policy towards interconnection with the private systems. Other than by requirements for technical compatibility, the customer is virtually free to use leased circuits in any manner he chooses. This facility, together with low circuit charges gives PGE a competitive edge in the area it serves.

The company has gone on record in the past in objecting what it claims to be discrimination against PGE or its lessees when interconnection between PGE private line circuits and those of the telephone company is desired.

4.3.4 La Compagnie Telephone Ungava Labrador Telephone Company

La Compagnie Telephone Ungava and the Labrador Telephone Company are independent telephone companies provincially chartered in Quebec and Newfoundland respectively. These companies operate the Quebec North Shore and Labrador Railway communication system and are prepared and capable of providing all services that may be offered by any major telephone company.

The companies offer no serious objection to interconnection with private systems provided the private system operator can meet the necessary technical, operational and maintenance standards to protect the integrity of the public telephone system. As examples private systems operated by the police and fire services in Labrador City and Schefferville have access to the public switched telephone network.

4.4 ENTREPRENEURIAL SYSTEMS

No major entrepreneurial system offering trunk circuits now exists in Canada. Norcom Telecommunications Limited, which provided trunk route communications in the Kenora area of Ontario was acquired in 1968 by Bell Canada. Restricted common carriers, which provide land mobile service and paging service on a hire basis appear to be the sole representatives of entrepreneurial systems in the country. Further details are included in Appendix B.

4.4.1 Norcom System

Norcom Telecommunications Limited owned and operated a private microwave network connecting the major centres in North Western Ontario (Fort Francis, Atikokan, Kenora, Dryden, Red Lake) carrying telephone channels between these centres under contract with Northern Telephones Ltd. and TV under contracts with the CBC. For TV the network was interconnected with the trans-continental CN-CP microwave system which carried CBC programs from Winnipeg to interconnection points - a private line service. For telephones the network was interconnected at many places with the Northern Telephones trunk line system, a public switched network, which in turn was interconnected with the municipal telephone systems of the various locations.

The evolution of an entrepreneurial system such as Norcom serves to illustrate how such systems can be successfully integrated with the public telephone network to provide communication to remote communities on an economic basis.

4.5 MANUFACTURERS

The following manufacturers of communication equipment were contacted for their views on interconnection:

a) Automatic Electric (Canada) Limited

b) Canadian Motorola Electronics Company

c) L. M. Ericsson Limited

d) Northern Electric Company Limited

Further details are given in Appendix C.

4.5.1 Automatic Electric (Canada) Limited (AE)

AE feels that uncontrolled interconnection of privately owned telephone exchanges with exchanges of the telephone companies will increase the problems of the equipment suppliers because most users will not be able to provide the degree and quality of maintenance needed to keep a telephone exchange operating within specified limits. Malfunctions due to inadequate maintenance also reflect indirectly on the workmanship of the equipment manufacturer and may cause considerable concern in the industry, to the equipment manufacturers, the common carriers and to the general public.

4.5.2 Canadian Motorola Electronics Limited

Canadian Motorola is one of the major suppliers of equipment used for paging service and land mobile service.

The company feels that the benefits of a radio paging service to both commercial and non-commercial users, in the form of improved efficiency in day-to-day operations would be further enhanced if the paging terminal facilities of the user could be interconnected with the public switched network.

In the land mobile service the situation is similar. Considerable benefit to the customer would accrue and, because design, reliability and maintenance of the associated equipment is continually improving, any detrimental effect on the public network is no longer an overriding factor.

4.5.3 L. M. Ericsson Limited

Ericsson supplies equipment to common carriers and to private users. However, Ericsson's present marketing policy discourages the sale of telephone exchanges to users having no technical capability to maintain the equipment.

4.5.4 Northern Electric Company Limited

The Northern Electric preference is to deal only with the telephone companies and at present is not oriented to the private system market but sees no difficulty in adapting to this aspect. The Company equipment development programs are predicated on the present common carrier policies which, if altered, may in turn alter major programs for the modernization of telephone company plant. Moreover, the Company feels that telephone system integrity would be lowered through uncontrolled interconnection and substandard installation or maintenance.

SECTION 5

INTERCONNECTION POLICIES

5.1 FEDERAL AND PROVINCIAL GOVERNMENT POLICIES

Telephone companies are incorporated under either Federal or Provincial Acts.

5.1.1 The various Acts are quite similar and the following is a list of pertinent points found in the Acts:

a) Telephone companies must meet all reasonable requests for service.

b) The service must be just and without prejudice to any person requesting service.

c) Similarly, charges and tariffs for service must be fair, just, without prejudice, etc.

d) Nothing may be connected or coupled to the telephone company's lines and equipment without the specific approval of the telephone company.

e) The telephone company may refuse a service if it feels that the requested service will jeopardize the whole system.

f) A telephone company may form an agreement with other telephone companies to interconnect their systems. If no agreement can be reached, the regulating government body will judge the case.

g) There is always a government body that regulates the activities of telephone companies.

h) Such regulating bodies arbitrate conflicts between telephone companies and the public. They are more concerned with tariffs but also handle questions of service, quality and reliability.

As can be seen, interconnection is left to the discretion of the telephone company within the limitations imposed by the Acts and Charters of Incorporation. The Acts specifically prohibit any

form of tampering with, connecting to, destroying, harming, mutilating and otherwise interfering with telephone company equipment.

The Provincial and Federal Acts and Charters have one common characteristic - no telephone company in Canada has been given the exclusive privilege to carry all communication traffic in its area of operation.

By law, the companies have the right to install equipment, erect structures, run wires and cables, use radio, and otherwise to further their objective of supplying a subscriber telephone network. But there is no implication that because a company has existing equipment in an area it is entitled to serve all telecommunications needs in that area. The important aspect of this is that any form of telecommunications, except public telephone service, is open to competition.

From the point of view of interconnection it is essential to distinguish between the services controlled by the Acts and Charters and the other incidental communication business handled by telephone companies. Thus, the public switched telephone network is protected and any question regarding interconnection is left to the discretion of the telephone company, while other services such as private lines can legally be supplied by anyone.

However, the broad wording of the various Acts and Charters allows the telephone companies to veto any form of interconnection whether such a connection would become part of the switched network or not.

5.1.2 Federal Bill C-11

Recent adoption of Bill C-11 amending paragraphs (30) and (31) of Section 2 of the Railway Act, brings the leased line services of the Federally chartered common carriers (Bell Canada, B. C. Telephones, COTC and CN-CP) under the regulatory control of the Canadian Transport Commission (CTC). There is no particular reference to the question of interconnection. However, by regulating private line rates, and by virtue of the fact that private lines of the telephone companies can be interconnected with the public switched network whereas the private lines of other carriers such as the railway companies are generally denied access to the public network, it is likely that Bill C-11 will have an effect on the competitive situation in the formation of private systems. More than before, interconnection privileges may become a deciding factor in negotiations for private systems.

5.2 COMMON CARRIER POLICIES

5.2.1 General

The comments from the common carriers given in Section 4.3, reflect the general attitudes of these organizations towards interconnection. Basically, for all types of interconnection, the common carriers within the limitations imposed by the regulatory authorities decide whether or not a required interconnection may be allowed. From the user's point of view there does not seem to be much difficulty in interconnecting a private system with the private line circuits of the common carriers. However, when interconnection with the public

switched telephone network is required, the common carriers tend to exercise their right to refuse to meet a customer's request.

5.2.2 CN-CP Policy

Of the major telecommunication carriers, CN-CP generally allows interconnection between their public network and private systems under the following conditions:

a) Technical compatibility of the private system with the CN-CP network at the point of interconnection.

b) The carrier has the absolute right to disconnect a private interconnected circuit, if, in CN-CP opinion, the private network introduces a degrading factor into the carrier's system.

c) The carrier will not guarantee the performance of the private network beyond the point of interconnection.

5.2.3 Telephone Company Policies

Telephone companies generally have a rigid attitude towards interconnection though the smaller telephone companies tend to be more flexible.

Telephone companies normally do not allow the connection of privately owned switching equipment to their own switching equipment apparently for two basic reasons. First are the technical problems of possible incompatibility of equipment and potential damage to telephone company service by faulty private equipment and sources of interference. The second reason lies in the difficulty of fitting the private system into the rate structure which is based on 'value

of service', i.e., as the utility of a service increases, so does its monthly rate.

Of the two Federally chartered telephone companies, BC Tel specifically disallows the interconnection of 'foreign systems and equipment'. Their Tariff Section II, Item 10, Rule 9 states:

"The Company's equipment and wiring shall not be re-arranged, disconnected, removed or otherwise interfered with, nor shall any equipment, apparatus, circuit or device which is not provided by the Company be connected with, physically associated with, attached to or used so as to operate in conjunction with the Company's equipment or wiring in any way whether physically, by induction or otherwise, except where specified in the Tariffs of the Company or by special agreement. In the event of a breach of this Rule, the Company may rectify any prohibited arrangement or suspend and/or terminate the service as provided in Rule 35".

Section XII, Item 325 goes on further to state that

"connection of subscriber-provided PBX's to company-provided Exchange Service trunks is not permitted".

However, Item 100, Subsection C(9) does state specific cases where private systems may be connected at BC Tel discretion.

"In special instances where the Department of National Defence and certain other Government Departments provide and maintain their own private branch exchange switchboards with associated distribution plant and telephone instruments,

connection to exchange facilities may be provided, at the Company's discretion. The monthly charge for the required central office trunks shall be equivalent to one and one half times the regular monthly rate for the number and type of trunks so provided. No charge will apply to subscriber-owned private branch exchange installations when hazardous or difficult conditions make it impractical for the Company to own and maintain the private branch exchange equipment. The foregoing is restricted to systems in operation on June 16, 1969".

Bell Canada, the other Federally chartered major telephone company, is also regulated in restricting the attachment of privately owned systems with wording in its Tariff similar to that of BC Tel Rule 9. This restriction was approved by Parliament in the amendments made in 1967-68 to the Bell act of incorporation. However, there is recourse to the Canadian Transport Commission. The relevant sections from 16-17 Elizabeth II, Chapter 48 are:

"4) For the protection of the subscribers, of the Company and of the public, any equipment, apparatus, line, circuit or device not provided by the Company shall only be attached to, connected or interconnected with, or used in connection with the facilities of the Company in conformity with such reasonable requirements as may be prescribed by the Company.

5) The Canadian Transport Commission may determine, as questions of fact, whether or not any requirements prescribed by the Company under subsection 4) are reasonable and may disallow any such requirements as it considers unreasonable or contrary to the public interest and may require the Company to substitute requirements satisfactory to the Canadian Transport Commission in lieu thereto or prescribe other requirements in lieu of any requirements so disallowed.

6) Any person who is affected by any requirements prescribed by the Company under subsection 4) of this section may apply to the Canadian Transport Commission to determine the reasonableness of such requirement having regard to the public interest and effect such attachment, connection or interconnection is likely to have on the cost and value of the service to the subscribers. The decision of the Commission is subject to review and appeal pursuant to the Railway Act".

SECTION 6

ANALYSIS OF CURRENT INTERCONNECTION SITUATION

6.1 GENERAL

A logical approach towards an analysis of the current interconnection situation requires consideration of the following:

a) Identification of various interconnection situations

b) Technical and operational issues

c) Commercial and economic issues

d) Analysis and conclusion

6.2 IDENTIFICATION OF VARIOUS INTERCONNECTION SITUATIONS

The various types of interconnection situations are broadly classified as:

a) Interconnection between private systems.

b) Interconnection between circuits leased from two or more common carriers by the same user.

c) Interconnection between user owned and user leased systems.

d) Interconnection between leased systems of two or more users.

e) Interconnection between private systems and the public switched telephone network.

6.2.1 Interconnection Between Private Systems

With minor exceptions (e.g. DOT, BC Hydro, Ontario Hydro, Hydro-Quebec) investigations failed to discover any major instance of

interconnection between private systems.

6.2.2 Interconnection Between Circuits Leased from Two or More Common Carriers by the Same User

This type of interconnection appears to be most common. There is no principal difficulty for users to obtain such interconnection but the common carriers may require that the lease arrangement be made through one of the participating common carriers as prime contractor subcontracting portions of the circuits to other common carriers. Thereby the "integrity" of the circuit as a whole is safeguarded and operational issues of maintenance, failure reporting, etc. are clearly defined.

6.2.3 Interconnection Between User Owned and User Leased Systems

Most of the major private users own some specific communication facilities which are not normally offered by common carriers. Investigations have shown that once technical matters are solved, problems seldom exist in interconnecting these privately owned circuits or equipment with those leased from the common carrier.

Broadcast companies, which make extensive use of common carrier wideband leased circuit facilities for distribution of their programs, fall in this category. In most cases studio links (i.e. the link from broadcasting studio to the common carrier terminal) are user owned and interconnection with the common carrier dedicated channel is permitted on the basis of an agreed technical specification. These prevailing arrangements appear to be satisfactory.

6.2.4 Interconnection Between Leased Systems of Two or More Users

This type of interconnection is equivalent to the interconnection between private systems as discussed in Section 6.2.1. Of various systems examined, those belonging to Hydro companies and to the DOT have such interconnections by mutual agreement.

6.2.5 Interconnection Between Private Systems and the Public Switched Telephone Network

Requirements for interconnection between private communication systems and the common carrier public switched telephone network present the greatest problem.

Most users of private systems classify their communication networks into operational or administrative circuits. The need for interconnection of one or the other type of these circuits with the public switched network varies widely depending on the nature of the private business.

Public Service Organizations

Organizations like DOT, police, fire, and hospitals offering public and emergency service require interconnection of their operational circuits with the public switched telephone network. The need for interconnection of the corresponding administrative circuits is considered of secondary importance since these are for internal use.

A number of DOT operational systems are interconnected with the public network but so far the lighthouse control and air to ground pollution control systems have been denied access. The reason for this situation could not be ascertained.

For emergency services operated by police, firefighting and hospitals, it appears that the independent telephone companies are more cooperative in permitting interconnection than the major common carriers. The reasons for this were not identified. The installations of the Department of National Defence also present some special cases not investigated in this study.

Hydro Companies

These companies own and operate extensive microwave networks to meet their operational needs. The study has indicated that for reasons of security they do not favour interconnection between their operational circuits and the public telephone system.

Both BC Hydro and Hydro-Quebec use their respective microwave networks for internal administrative purposes, and the public telephone service is used for communication with the outside world. Hydro-Quebec has rented some of its circuits to Bell Canada and Quebec Telephone for the extension of public telephone service to some of the remote hydro electric generating stations.

Ontario Hydro, on the other hand, depends entirely on a private wire system leased from Bell Canada to meet its administrative needs. These circuits have access to the public switched telephone network. Interconnection by PBX patching of the operational circuits with the public switched network is allowed under emergency conditions. In addition to these leased administrative circuits, all hydro stations have independent access to the public telephone service.

Oil and Gas Transportation Companies

Oil and gas transportation companies, like hydro organizations, do not favour interconnection between their operational circuits and the public switched telephone system. For administrative circuits, however, such a facility is considered vital particularly for reasons of safety and security of the company personnel living in remote locations.

All users interviewed in the course of the study use circuits leased from the common carriers to meet their major communication needs. Interconnection requirements have been met to a large extent but users complain of the protracted period of negotiation necessary before facilities are made available.

Private Industrial and Commercial Organizations

Cases of private systems operated by industrial and commercial organizations cannot be generalized. They vary from totally independent internal systems made up from user owned or leased facilities, without interconnection, to totally interconnected networks leased from a common carrier. It appears that in the latter case exceptions occur insofar as the common carrier leased interconnected network may contain the odd user owned facility.

Resource Development Companies

Resource development companies, particularly those operating in the north, are provided with service facilities which allow them to interconnect their own radio telephone equipment with the public switched network as long as the requirement does not exceed one or

two telephone circuits. However, in the case of private land lines or wideband radio systems, the user is faced with interconnection difficulties. The problem then is to either divide the network into two parts, one serving the internal needs of the company and the other providing access to the outside world, or to treat both as an entity and negotiate an appropriate agreement with the connecting common carrier company.

Computer Utilities

Computer utilities companies do not normally require interconnection between the public telephone system and their leased data communication channels. However, for greater flexibility and benefit to their customers, (and obviously for the betterment of their own business) these companies would prefer to have all customer leased circuits, including CN-CP Broadband circuits, connected to the public switched telephone network. The study failed to discover any instance of interconnection between CN-CP Broadband circuits and the public switched telephone system.

RCC Operations - Paging and Land Mobile Service

There is evidence that manufacturers, RCC operators and their subscribers, and operators of private land mobile systems would benefit by interconnection to the public switched network. The concern of the carriers about the implications of such interconnection on technical grounds is becoming less valid, but the economic impact cannot be neglected and requires further analysis.

Hotels

Hotels represent another case of private commercial organizations. They have a clear requirement for a complex internal communication system serving a wide variety of needs, and at the same time

for complete access to the public switched network. For reasons of economy they may wish to operate their own internal system, however the interconnection problem has prevented them to combine the internal and external requirements into one system. With the exception of a very few isolated cases all hotel PBX installations are owned by, and leased from the telephone company serving the particular area.

6.3 TECHNICAL AND OPERATIONAL ISSUES

Due to the diversity of requirements, there are many technical and operational problems associated with the interconnection situation, the primary objective always being to ensure that the provision of such a service does not in any way, directly or indirectly, produce an adverse affect on the public switched telephone network.

In the course of discussions, both with the users and the common carriers the question of technical compatibility was often raised but it was not possible to establish whether clearly laid down standards for different interconnection situations actually exist. It was, however, recognized that the technical issues are not the major stumbling blocks.

Operational problems of common carriers encountered due to interconnection cannot be ignored and maintenance is considered to be a problem of major import. However, these problems may not be so formidable once standards of equipment, installation and interconnection are clearly laid down. Further, suitable maintenance agreements between the users and the common carriers may assist the latter in

solving any operational problems created through the provision of interconnection.

6.4 COMMERCIAL AND ECONOMIC ISSUES

6.4.1 General

The paucity of public information on interconnection cases made it impossible to carry out a quantitative analysis. Instead, the work is oriented more towards a qualitative approach, aiming to identify the economic and commercial factors that may have influenced the present interconnection situation. Furthermore, an attempt has also been made to isolate various issues which would merit further economic and statistical analysis in order to provide realistic guidelines to future policies on interconnection.

6.4.2 Two Basic Assumptions

The analysis of the basic issues in interconnection from the economic point of view is governed by two main assumptions. One is that the operation of the telecommunication services in Canada should be as free of unnecessary restraints as the nature of the service will allow, i.e., competition should be the rule and public control or protection of monopoly position should rather be the exception. Whenever the present monopoly position enables the telecommunications carrier to hinder or delay the introduction of services or facilities that may be beneficial to the economy at large, without showing that such introduction would impede its operations unduly, decrease its service to the public, or adversely affect the total economic benefit to the country, competition should be allowed.

The second assumption is that the public at large should not be made to protect either the level of revenue, a given rate of growth in the volume of business, or the right to all future development in the business to any telecommunication carrier simply because it has a charter to conduct certain business on an exclusive basis in a given area. The only right such a charter gives is to assure the franchisee that in consideration of his provision of the specified service of convenience and necessity to the public at large he shall be protected from ruinous competition and that should there be a change in the technology or business practices affecting his service he shall be first to be given an opportunity to provide service under the changed circumstances. Public control over franchised operations need not provide anything more than the opportunity for a fair return on investment.

The possibilities for increased service to the public due to the vastly increased telecommunication needs and the development of corresponding technical equipment and service packages outside the established common carrier industry raises the issue whether such a change in the nature of the business has taken place that the public interest would not be better served by a more liberal policy towards interconnection than the one presently in practice.

6.4.3 Issues in Interconnection

In the absence of empirical data it is extremely difficult to provide the logical justification of the current interconnection situation on economical grounds and to recommend action one way or another. We can now only investigate in general the possible economic

effects of interconnection on the carriers and the public at large.

From the purely economic point of view it does not make much difference whether the lines and equipment to be interconnected are leased from the carriers or are owned by the users if the total costs including those to the public at large are the same. We could then dismiss the distinction between systems composed of leased facilities, leased and owned facilities, and owned facilities. This distinction becomes valid where the total cost of facilities differs on the basis of ownership which is the case when a strictly private acquisition of facilities is compared with the expansion of the switched network plant of a common carrier. As mentioned earlier the rates quoted by common carriers do not necessarily reflect the cost of a specific addition to their plant but are based on the costs of the overall operation (cost averaging) and the value and operational expense related to the particular extension of the public network. The fact of interconnection with the public network is therefore a determining factor in the economics of private systems.

On the basis of the above observations, the interconnection between circuits leased from two or more common carriers by the same user and the interconnection between user owned and user leased systems, referred to in Section 6.2 should not present any problem, as long as technical and operational questions can be settled. Comments in Sections 6.2.2 and 6.2.3 substantiate these conclusions.

Thus, the economic study can be limited to two other cases of interconnection, namely,

a) Interconnection between private systems,

b) Interconnection between private systems and the public switched telephone network.

6.4.4 Interconnection Between Private Systems

This case can be subdivided in two. The first instance is interconnection between physically closely situated systems that can be connected without infringing on the telephone company franchise. In such an instance no regulation can be applied under the free enterprise system (e.g. all the tenants in one building can be interconnected privately with the next building in the block or within the confines of the property).

The second instance of interconnection of private systems is over an intervening expanse of space outside the private property on which they are situated. In this case either the aid of the franchised common carrier is needed or the operators would need to establish their own link by a special permit.

In the case where special use and special equipment may be involved, interconnection of private systems by a separate private link may be justified (e.g. hydro lines, railroad, etc.). In the case of common telecommunications needs, permission to operate an independent connection link may lead to "cream skimming" if this arrangement causes substantial reduction in revenue of the franchised company earned through the public switched telephone system. This latter situation may be taken care of by the use of leased wire from the franchised common carrier to interconnect the two private systems

in which case the private line rates will safeguard the carrier against losses. It is then the customer's choice to pay for common carrier service either through public network rates or through leased private line rates.

6.4.5 Interconnection Between Private Systems and Switched Network

In the question of interconnection between a private system and the switched network, three system structures are possible - one in which the private system is local and long-distance connection is provided by the common carrier, another where the long-distance link is provided by the private system, and a third structure where a private system is interconnected with the carrier's local network.

a) Local private system interconnected with the common carrier long-distance network. In this case, apart from technical considerations of compatibility of equipment and network integrity and reliability of service there are no issues of significance. This has been decided by the Carterphone case in the United States. If foreign attachments can be connected to the public network on individual terminals, an addition of a system is no different. The effect on the carrier's revenue would be, at the most, equal to the extension of WATS rates to all the calls from the private system.

The effects of interconnection between private systems and the public switched network will therefore

be beneficial to the private network. Its aggregated charges for the long-distance interconnection will not increase, but will most likely decrease with the availability of WATS rate. However, system integrity is involved and the private system may by the possibility of denial of interconnection be forced to invest more in its plant.

b) <u>Long-distance link is provided by the private system.</u> In this case the private network can hypothetically deprive the common carrier of some of its toll route revenues by duplicating facilities available on the same route. As there is less control over the operation of the private network the integrity of the system could be impaired through negligence of the private system which is not accountable for its operations to the public.

This case of the interconnection between privately owned trunk communication system with the public switched telephone network is of special interest. Many sparsely populated and remote development areas cannot economically support a common carrier owned telephone system and associated trunk network. Development companies in these areas often operate long distance systems for their own administrative use, with sufficient capacity to carry additional circuits.

The question arises whether members of the public should be allowed to use such private systems and should such systems be interconnected to the switched network, since the extension of parallel facilities by the common carrier would mean duplication of expense without any hope of recovery for the common carrier within a reasonable time.

Under such circumstances complete denial of interconnection would be against public interest in the area concerned. Also the attempt to force service by the common carrier at standard rates would be to the disadvantage of society since this service would have to be subsidized by the carrier's other operations. Therefore the public's interest would benefit by solutions based on appropriate arrangements between the common carrier and the private organization. There are various alternatives for such arrangements. The telephone company may own all terminal facilities which are to be connected to the public switched network, and may lease from the private organization the trunklines subject to performance specifications. This creates problems of terminal equipment maintenance unless a joint maintenance agreement can be worked out. Or all facilities may be operated by the private organization under an interconnection agreement with

the telephone company similar to a privately owned PBX installation. This poses problems of a technical nature since control is not in the hands of the telephone company. Another solution is for the private operator to lease all his facilities, the internal ones as well as those which are to be interconnected, from the telephone company at rates which are acceptable to the telephone company from the point of view of its overall operation. The latter solution is likely to be the preferred one by the telephone company, but is usually more expensive to the private organization because of the earlier mentioned difference between facility costs and carrier charges. However, it must be realized that interconnection, whichever way it is established, involves costs which account for increased expenses of a widely distributed nature and which are to be weighed against the increased value of the operation.

From the carriers point of view these types of systems even if completely operated on a private basis, are beneficial, because they result in business from an area where there was no business before. The maintenance of the carrier's monopoly position within the region, if in fact such a position was existent, could perhaps be safeguarded by special agreements

between the common carriers and the private systems by which the public service part of the private network could revert to the common carrier after it reached a certain volume.

c) Interconnection of a private system with switched local network.

In this case, interconnection is no different from that of an installation of a PBX if the private system is a not-for-hire facility.

Important issues arise, however, if the private system is selling its services to the public. Two situations can be distinguished. In one, services offered by the private system are of a highly specialized nature sold to a relatively narrow group of subscribers, such as store and forward data processing, etc. In the other, the service is of a general nature and is offered to the public at large.

In the first case, significant benefit to the users of the communications facility could result without burdening the public carrier with the provision of expensive and complex equipment that may have only a limited market. Businesses that could use that particular service are likely to make use of it where previously they had to rely on alternative means of communications or had no communications. This type

of service is effort-intensive and by its nature may not suit the common carrier operations, although the value received by the special customers is high. System integrity is again involved and the private system costs cannot be looked at in isolation. The costs to the public may be higher as a result of the implications of interconnection.

In the second case, the telecommunications service could be offered to the public in direct competition with the services of the common carriers. It is hardly conceivable that such a system would include more than the occupants of a building or a block in urban areas.

Hotels and large office complexes are the most likely candidates for private local systems. Large apartment developments are also a possibility. Among mobile users paging systems with call-in possibility may become important.

What would be the effect of interconnection in such cases? Insofar as the carriers are concerned the direct revenues will decrease, but so will the investment in terminal equipment. However, the costs of the system itself and the technical and operational costs arising for the carrier company out of the interconnection of the systems addition, presumably reflected in an interconnection charge, will have to be borne by the segment of the public that happens to form the

users of the system. Also problems of system integrity arise because the telephone company is not in control of operation and maintenance of the private system which may affect the overall standard of service.

Resolution of the question whether public policy should or should not allow small local private systems serving public customers in areas served by franchised telecommunication carriers needs further quantitative analysis of all factors, costs and benefits, that enter into situations of this kind.

6.5 ANALYSIS AND COMMENTS

Analysis of various cases of existing interconnection and consideration of the economic, commercial, technical and policy issues involved therein indicate the following:

a) There appear to be no set technical standards for various types of interconnection situations experienced.

b) Situations requiring interconnection between private systems (user owned or user leased or a combination of both) are not widespread at present and have not, therefore, posed any serious problems.

c) Situations requiring interconnection between circuits leased from two or more common carriers by the same user are quite common. The common carriers seem to have reasonably consistent policies towards providing such interconnections provided that certain criteria

are met (for example leasing through a prime contractor)

d) Situations requiring interconnection between user owned and user leased (same user) systems do not appear to present any serious problems. Common carriers seem to have a reasonably consistent policy towards providing such interconnections.

e) For almost all cases of interconnection situations examined, requirements exist for some form of interconnection with the public switched telephone network controlled by the common carriers. Unless leased entirely from common carriers, the required interconnection is difficult to obtain and provision of interconnection appears to be the exception rather than the rule.

An examination of the economic, commercial, technical and operational issues discussed in Sections 6.3 and 6.4 seems to indicate that the common carriers' general reluctance to provide public network interconnection to the private system users is governed more by the economic and commercial effects of such a service rather than by technical issues. In cases of large users, generating substantial private line revenues for the common carriers, exceptions in interconnection privileges seem to be more frequent. Smaller private systems may face considerable problems even for emergency use.

Hotel systems present a particular case in which the establishment of private systems with interconnection to the public switched

network has been consistently denied.

The negative attitude towards providing interconnection to some of the essential services of DOT, police, fire, and hospital services, and to remote resource development companies cannot be explained. These organizations are involved in operations which directly or indirectly render public service with a vital requirement for access to the public switched telephone network.

There appears to be a requirement for interconnection between CN-CP Broadband circuits and the public switched telephone network. Telephone companies have so far refused such facilities.

Interconnection between RCC controlled systems (paging, land mobile service) and the common carrier switched telephone networks would probably benefit the manufacturer , the operator and the subscriber but the common carrier negative attitude on economic rather than technical grounds requires further examination.

6.6 USERS VIEWS

In the course of our discussions with private communication system users, many expressed concern about problems and frustrations they had experienced in their negotiations with the common carriers with regard to all types of communication services. These are summarized as follows:

a) Customer requirements even of a relatively simple nature involve often complex technical, operational and particularly economic problems needing thorough analysis and clarification. The comment then is that common carriers are slow to appreciate customer needs and to display flexibility in finding solutions.

b) The common carrier reaction to interconnection requests is generally negative, unless based on a comprehensive lease arrangement.

c) With the exception of the hydro companies, most users interviewed expressed their preference to use common carrier facilities, rather than owning their own systems subject to the condition that the services offered by the common carriers are economical and are tailored to meet customers' requirements.

SECTION 7

FUTURE INTERCONNECTION TRENDS

7.1 GENERAL

In the assessment of possible future trends two cases are of particular interest:

a) Expansion of user owned networks and interconnections of such networks.

b) Development of wideband cable systems.

7.2 USER OWNED SYSTEMS

Expansion of user owned private systems, besides having a direct effect on the common carrier's public network business, would affect the carrier's private line business and thereby indirectly influence the public network economy. If the private systems then would interconnect with each other, for example in the hypothetical case of an interconnection between the telecommunication systems of Hydro organizations, the systems users may directly benefit from the expanded operation but the impact on the costs to the public at large through the effect on the common carrier business in that area could be substantial. Apart from the trend towards larger private systems - which by itself is not a subject for study in this report - there is no doubt that the question of interconnection between these systems, which could theoretically lead to a nationwide private network, requires a more thorough economical investigation than possible within the scope of this report. Technically, apart from radio frequency

licencing, there is presently no way of preventing certain interconnections as long as they do not extend into the public network domain. In the future, if present trends persist, the introduction of some regulatory function will become inevitable.

7.3 WIDE BAND CABLE SYSTEM

A situation may arise in the future when new development areas or high-rise buildings may have inbuilt wideband cable systems suitable not only for television service but also to carry telephone, data or facsimile. This is often referred to as the "wired city concept". Two types of interconnection are foreseeable.

a) Between the private system and the common carrier private line system for services other than telephone.

b) Between the private system and the common carrier switched public telephone network.

The first situation concerns the common carrier private line services which through the private line rate structure (either regulated under Bill C-11 or through inter-company agreements) will presumably reach a clear definition.

The second situation is analogous to a PBX interconnection with the added complication that the "wires" besides carrying telephone carry other types of traffic, not compatible with the telephone service. Serious technical problems arise from the requirement for complex interface equipment to segregate distinctly the different types of service. Unless provided completely through the facilities of the common carrier it is impossible at this stage to see how a

compromise between the public network requirements for systems integrity and the interests of the private service agencies could be reached. The costs arising out of the interface requirements would have to be borne by the private system users in addition to whatever costs are associated with the interconnection. Although simple at first sight the concepts of the "wired city" have not been sufficiently developed yet - technically and economically - to allow an assessment of the economical impact of interconnection with the existing public networks.

SECTION 8

ROLE OF GOVERNMENT

8.1 GENERAL

Government at all levels from federal to municipal has a dual role in telecommunications. On one hand it has the power to regulate within the constraints of the various acts and regulations. On the other hand it is itself one of the major users of the country's telecommunication facilities. Therefore, policy decisions and regulatory action on an issue as fundamental as interconnection have a bearing on the country's economic development as well as on the Government's own effectiveness in administration and the exercise of control in matters of national security and emergency.

In the Canadian environment which consists of a mixture of public, private, regulated and unregulated operating entities, a policy of general enforcement of interconnection of all facilities would without doubt be technically, operationally, and economically unacceptable. On the other hand the lack of a general interconnection policy as it practically exists at present creates problems as outlined in this report. To arrive at an intermediate solution for policy development the basic principle of providing maximum benefit to the public by judicious regulation of interconnection situations would require that effective technical and economic guidelines, standards and regulations be established to remove unnecessary restraints on the development of overall system flexibility. Proper attention

could then be given to organic growth of the common carriers' plant, to the introduction of imaginative approaches and the enterprise of innovators. A typical illustration for this can be seen in the extension of plant and facilities into sparsely populated areas where the economic difficulties of providing service by the established common carriers have many times been countered by the unrestrained flexibility of local entrepreneurs, leading often to complex interconnection problems whose solution would benefit by the existence of a definite public policy.

Whatever policies towards interconnection are adopted, the first aim must be directed towards the economics for the public at large and the preservation of system integrity i.e. emphasis must be given to quality and standard of public service at reasonable cost offered by common carriers. On this basis the following areas present themselves for consideration:

a) Technical and operational standards.

b) Private line interconnections.

c) Switched public line interconnection.

8.2 TECHNICAL AND OPERATIONAL STANDARDS

Investigations have indicated (Section 6.2) that no set rules for technical, operational and economical standards are readily available for the many variations of the interconnection situation as experienced in actual practice. The availability of such standards would not only simplify many interconnection problems but would also provide impetus to the overall improvement of the private communication

systems across Canada.

Government can play a major role in developing guidelines for suitable standards and in ensuring that all systems operational in Canada meet the desired economical, technical and operational requirements.

8.3 PRIVATE LINE INTERCONNECTIONS

Private line services offered by any carrier organization (common carrier or entrepreneur) add to the flexibility and coverage of the overall telecommunications network and if interconnected with the public switched telephone system do not necessarily affect the latter's integrity as long as appropriate standards of operation are maintained. In the interest of responsiveness to the users' needs a variety of services is desirable, and the existence of competition introduces beneficial effects in this respect.

In recent years, there has been a growing demand for private communication services both by the government and business users. With the advent of teleprocessing the demand is expected to grow at a rapid pace. It is here where private and entrepreneurial systems may be able to bring in imagination and innovation at a faster rate than possible with the existing plant and facilities of the common carriers. The problem of devising policies on interconnection between private and common carrier systems is therefore intimately related to the more general problem of devising a regulatory basis for the control of extent and growth of the private and entrepreneurial systems themselves.

Interconnection situations of immediate interest in the private line sector can be classified as follows:

a) Interconnection between circuits of two or more common carriers leased by the same user.

b) Interconnection between private systems.

Of these, as our investigations have shown (Section 6.2.2) the situation as defined in a) is in a satisfactory state and does not require immediate action aimed at altering the present situation.

With regard to b), there are presently not many private systems with mutual interconnection facilities. However, future trends in communications will with all likelihood encourage the development of such interconnected systems (Section 7.2). Although this may be considered undesirable by the common carriers' because of potential loss of revenue, the public interest may be better served by a public policy which decides approval or disapproval of interconnection on a case by case basis.

8.4 SWITCHED PUBLIC LINE INTERCONNECTION

Situations requiring interconnection between private communication systems with the public switched network appear to create considerable problems. On the basis of our investigations, various cases requiring interconnection can be broadly identified as follows:

a) Interconnection requirements for DOT, police, fire and hospital services and other public emergency services.

b) Interconnection requirements of the resource development

and public utility organizations.

c) Interconnection requirements of other private organizations.

d) Interconnection requirements of hotels.

e) Interconnection requirements for CN-CP private line circuits.

In the case of a) above, public interest and security are affected, and this will have to be the basis for the development of public policy. There is no reason why interconnections could not be made mandatory provided that the cost distribution is clearly defined and all technical and operational problems are settled. But at least, the provision for appeal by the organizations concerned against unilateral common carrier decision, would present a safeguard.

Resource development and public utility organizations, directly or indirectly, serve public interest and often pioneer the extension of communications in the remote parts of the country. It appears that in the public interest these organizations, too, are preferred candidates for interconnection. Should this be declared policy these organizations must be given the opportunity to appeal to appropriate authorities against common carriers' decisions.

With regard to c) our investigations have indicated that difficulties arise when the common carriers are requested to provide public switched network interconnections to communication systems of private organizations. The question of whether such requests are in the public interest or not cannot be answered on a general basis.

Economic circumstances vary considerably from case to case, even when full compatibility and systems integrity are assured. The only viable alternative appears to be a case by case decision giving the private operator the right to appeal against the common carrier decision whenever a dispute arises.

With regard to interconnection needs for hotel private systems and CN-CP private line services, our investigations have demonstrated the need for further study of such requirements. Since solutions of these interconnection situations may have far reaching effects on private users, common carriers and users of switched networks, further examination through public enquiry under an appropriate authority appears to be required.

SECTION 9

CONCLUSIONS

9.1 The examination of interconnections between private telecommunication systems and those of the common carriers have identified the following:

a) No set rules for economic criteria, and technical and operational standards for interconnection uniformly applicable throughout Canada exist.

b) Private system operators, with the exception of some public services such as police, fire fighting or hospital services, do not require or want extensive interconnection with the public switched telephone network.

c) Common carriers do not seem to have a uniform policy towards interconnection of private systems with the public telephone network with the exception of hotel systems for which private system interconnections are generally denied.

d) TCTS does not provide access to the public switched telephone network for CN-CP data channels. Users claim that this affects their operations adversely in terms of flexibility and costs.

e) Interconnection of circuits leased by a private user from different common carriers is possible subject to certain conditions in the lease arrangements. However,

interconnection of circuits leased by different private users encounters objections, though TCTS policy allows such interconnection.

f) Interconnections between privately owned systems do not exist at present, except for some isolated cases. However, the potential for such interconnection exists and may create problems for the common carriers in the future, unless regulatory control is introduced.

g) Bill C-11 is intended to regulate the leased line services of the Federally chartered common carriers. Because of the differences in interconnection privileges obtained from different common carriers the growth pattern of user leased private systems is likely to be affected.

9.2 On the basis of the above observations the report concludes that:

a) Rules and guidelines covering economic criteria, and standards for performance, maintenance and operation are desirable to allow private system development with interconnections within the overall telecommunications complex.

b) Interconnection between private line circuits of different carriers leased by the same user allow the build up of private systems subject only to appropriate lease arrangements with the common carriers.

c) The situation created by the interconnection of two or more privately owned communication systems requires further attention.

d) Subject to the development of economic and technical criteria (para a) above) private networks serving the public for emergencies and protection require consideration for interconnection with the public switched telephone network.

e) Similar to d) above, communication networks operated by the public utility and resource development organizations require consideration for interconnection on the basis of their effect on the growth of the overall telecommunications complex.

f) The possibility of appeal to a regulatory authority in cases of dispute between a private systems operator wishing to interconnect with the public switched network and the common carrier serving the area appears to be desirable (it already exists in certain areas).

g) PBX interconnection and CN-CP Broadband interconnection to the public switched network require further investigation. Since private users, industry, and governments are involved enquiries need a broad basis such as public hearings on a commission basis.

h) The effect of the interconnection situation on private line system development with regulated private line rates needs further study.

APPENDIX A

USERS

USER: ALCAN ALUMINIUM LIMITED
Montreal, P.Q.

1. The Alcan communications network is an extensive, national and international system which includes switched teleprinter message, voice and data facilities.

2. With the exception of a short 6 GHz microwave system which is owned by the company, all circuits and equipment, other than computers, are leased from the telecommunications carriers. Within North America these are provided through Bell Canada, with overseas circuits provided by COTC.

3. The system comprises a control centre in Montreal, sub-centres in the U.K. and Guyana for teleprinter traffic to terminal users, and an extensive telephone network covering Ontario and Quebec with spurs to New York State.

4. Teleprinter messages are handled by store-and-forward method, computer-switched in Montreal over leased circuits operating at 45, 50 and 75 bauds. Telex and TWX provide the interface with points not connected to the network.

5. Apart from L.D. calling, voice communication is by private lines between company operated switchboards and, in general, these circuits are employed only for voice traffic.

6. Data transmission between Montreal and the data centres occupies only a small percentage of the available voice circuit time therefore the utility of voice circuits is increased by designing them for alternative data.

7. Because of the totally private, leased nature of the system intended solely for the use of the company, there is no interconnection problem of company owned computers and internal wiring via the leased switchboards on Alcan premises. Interconnection via company operated, leased switchboards with the public switched telephone network for company business is sanctioned.

8. Alcan does interconnect various computer systems, one to the other via leased interface equipment and private lines.

USER: BRITISH COLUMIBA HYDRO AND POWER AUTHORITY
970 Burrard Street
Vancouver 1, B. C.

1. According to BC Hydro the microwave network is an integral part of the power system, and they did not feel the desired reliability of 99.999% and system security could have been achieved if BC Hydro had to lease the transmission media for the power system protection signals from the telephone companies or other carriers.

2. Seventy-five percent of the operating circuits for BC Hydro are used to carry data and protection signals. Between 30 and 40 trunk voice channels are available for administrative use. DDD facilities are available throughout using PAX units leased from BC Tel. Outright purchase of PAX units was considered but was uneconomical.

3. There is no interconnection between BC Hydro Microwave System and the public telephone systems. Such interconnection was never contemplated as this was thought to be detrimental to the basic operating philosophy. However, leased extensions from various PAXs exist.

4. Interconnection with the Bonneville Power Communication System is available at Ingledow Substation.

USER: CANADIAN BROADCASTERS

Bushnell Communications Limited
Ottawa

Broadcasting Station CFAC
Calgary

1. Broadcasters make extensive use of common carrier wideband private line facilities for carrying signals from studio to transmitter sites and for network distribution.

2. In many cases the communication circuits between the broadcasting studio and common carrier premises are privately owned. These privately owned systems are interconnected with the common carrier networks in order to carry information to desired destinations.

3. Since broadcast circuits are special purpose circuits both broadcasters and common carriers co-operate with each other to achieve the desired operational standards.

4. No interconnection problems exist and all technical requirements for interconnection are well defined and agreed before the common carrier service is acquired.

USER: CANADIAN ELECTRICAL ASSOCIATION

(The following submission was made on 20 April, 1970 for the Canadian Electrical Association by A.C. Beresford, CEA representative on Telecommission Study 8(b). As will be noted these comments will appear in the sub-study 8(b)iii, Terminal Devices, as well as appearing here.)

The Canadian Electrical Association is the national association formed by the major electric power generating, transmitting and distributing utilities in Canada, together with associated manufactures and suppliers. The electric utilities of all ten provinces and Yukon are represented, including all eight provincially-owned organizations. Generating capacity of approximately forty million horsepower serves over six million customers in Canada and the capital investment of the utilities is over twelve billion dollars. Over225,000 circuit miles of telecontrol facilities are used to ensure reliable, low cost, electric power service to the public.

From the electical utilities' point of view, it is somewhat difficult to make a clear distinction between interconnections which fall under the terms of reference of Study 8(b)i and those that properly fall under 8(b)iii. Any attempt to separate the material will only result in an oversimplification of some rather basic user interconnection problems. Furthermore, in large measure, the majority of problems arise principally from tariff (and in some cases arbitrary) rulings

of the common carriers as to just what they will, or will not do, in various interconnection situations.

Historically, the common carrier attitude toward interconnections is based upon the fact that for many years no other organizations understood the problems associated with speech transmission. In many instances, this was used to restrict attachments and interconnections and perhaps the attitude was technically justified twenty-five years ago. Most assuredly this is no longer the case, and today many organizations, both manufacturing and operating outside the common carrier field, fully understand telephone theory and practices. These organizations have competent communications engineering staff, who are entirely capable of designing, installing, measuring and applying the equipment and parameters involved. Furthermore, as users they are in a much better position to appreciate and solve their own unique problems and needs. Today, measuring equipment and methods have become more precise and standarized throughout the whole communications and control industry, and both the user and the common carrier are talking the same language. It is, therefore, now possible to specify conditions in technical terms only and which may be measured and understood by both parties. An interconnection agreement can therefore be drawn up between the two parties clearly detailing the conditions of interconnection and the responsibilities of each.

There is nothing unique or mysterious about such an agreement, and in fact this is precisely what is done between the various members of the Trans-Canada Telephone System, and also the telegraph companies, where the telephone companies lease channels to and from the telegraph carriers.

There is, therefore, no reason today why this cannot be done between any common carrier and a properly engineered and maintained private communication system.

Leased facilities (as opposed to wholly owned circuits) have been used by power utilities for many years. The majority are used for telecontrol and protective relaying, and usually consist of short cable and direct wire circuits, where no other facilities are available. There are few, if any, relaying tone assistance channels on leased facilities in Canada.

Modern society has become completely dependent on reliable electric power. The primary consideration in the planning and design of any aspect of the network must always be one of utmost reliability. Telecontrol, including whatever medium is used to carry the intellignece, must always be considered an integral part of the modern power system. The utility must therefore be in a position to specify and control not only the technical requirements for the circuits, but also the day-to-day and long-term operation and management factors governing the supply, use, maintenance, operation and availability of the circuits. It is for this, and important technical reasons, that

utilities install and operate their own wholly-owned communications systems in the majority of cases. The privately-owned systems must for technical reasons equal the quality and reliability of circuits available from the common carrier. Common carrier systems are designed on the basis of average speech use, and could not tolerate the high duty factor of continuously operating tone and telecontrol equipment as required by electrical utilities. An example of this is the fact that a microwave system designed to handle 600 voice channels as installed by a telephone carrier, would in reality only be able to handle a total of 120 channels if subject to the duty factor requirements of the electrical utility equipment. This is not intended to imply that there is a fundamental weakness in the 600 channel system of the common carrier, but simply that the system is designed to satisfactorily handle speech, but not the specialized requirements of an electrical utility.

Having in mind the above background, the Canadian Electrical Association attempts to approach interconnection agreements from a purely objective point of view. We always ask ourselves the following question when negotiating an interconnection agreement. "How would we, as an electrical utility, react to the interconnection of unknown devices to our network having due regard for connected load and the possibility that incipient failure may cause system degredation?" Having asked the question, our reaction is generally one of acceptance of interconnection

provided that technical incompatibilities are eliminated, the device is engineered, installed and maintained by competent persons, and that each party clearly understands his responsibilities. In other words, we approach the interconnection from a purely objective engineering basis, and we sincerely believe that the same approach should be taken in negotiating interconnection agreements between private systems and the common carriers.

In preparing this submission, the Association circularized all utility members and the following are extracts from the survey:

(1) Existing interconnection agreements differ radically from one end of the country to the other, with the most restrictive interconnection practices appearing to exist in the mid-western part of the country and the most liberal being on the west coast. There are some indications that, in the event of possible future major interconnections on the east coast, here the common carriers might become excessively restrictive.

(2) Maximum system levels, as permitted by the common carrier, do not appear to present too much hardship to the utilities in most non-critical applications. Open wire leases do however present many problems due to poor signal-to-noise ratios and reliability.

(3) Terminal devices which interface the common carrier and the utility do not appear to present many problems. Where problems do arise, little difficulty is experienced in rectifying them as the necessary parameters are fairly easily verified.

(4) The terminal device (where it is the interface) should preferably be owned and maintained by the party that can most efficiently maintain it on the basis of rapid service and economics. Many utilities would prefer that the device be electrical utility owned where it is on utility property.

(5) Standardization and multiplicity of terminal devices do not present a selection problem to electrical utilities.

(6) (a) Where a channel of a defined bandwidth is leased from a common carrier, the user should be permitted to multiplex or subdivide the channel as he so desires, having due regard for composite levels specified by the common carrier.

(b) In some instances, common carriers exercise an additional 25% interexchange charge where the customer instals multiplex equipment. The utility position is that this charge is unreasonable and should be dropped.

(7) Leasing and rental charges elicited very little comment, although the point was made that circuits are leased on a

"zone" basis, which approximates a charge per mile, whereas in reality the charges are more nearly on a cost per terminal basis.

(8) (a) All utilities foresee the day where readings from residential customer metering installations will be performed automatically by way of the local public exchange telephone network.

(b) Similarly, many foresee the day when isolated stations will automatically report troubles via the D.D.D. network.

(9) Of necessity most utilities custom design their own dispatch consoles. These consoles invariably incorporate utility designed and owned telephone switching equipment for private circuit facilities. In many areas, the telephone company refuses to permit termination of the local public exchange line on the utility switchboard, despite the fact that measures may be taken to prevent deliberate or accidental interconnection of the two systems. Instead, the telephone company insists upon installation of a separate telephone instrument which is inefficient, invariably unharmonious and incompatible with the overall decor, and generally does not permit of even a separate panel mounting for the dial. This is considered to be a most unreasonable approach with the

situation being more the rule than the exception across the country.

(10) Most utilities report dissatisfaction with the frequent, unexplained, precipitate, and unannounced short interruptions which take place with leased facilities. Many utilities have resorted to installation of interruption counting and alarming devices upon their leased pilot wire channels because of this widespread problem. The problem is believed to be caused by telephone company personnel who are unfamiliar with the requirements for constant continuity of even an apparently insignificant pair of leased wires. An almost constant program of education, plus day-to-day contact with local telephone representatives has helped but unless continuity of personnel is maintained in the telephone regional organization, the problem immediately re-appears. It is worth noting that this problem, perhaps more than any other, forced electrical utilities, in both the U. S. A. and Canada, into their first privately owned cable and open wire facilities some thirty to forty years ago. It is interesting to note the apparent impossibility of solving this interconnection problem even after all these years.

(11) Many utilities expressed dissatisfaction with the vulnerability of telephone company cabling facilities in urban centres. The constant severing by contractors, finger trouble by telephone personnel, extremely small wire

gauge, high transmission loss, and the lack of any guarantee of priority of restoration in re-splicing damaged cables, is of extreme concern to many utilities.

The foregoing has outlined the historical background of the seeming reluctance of common carriers to interconnect with privately-owned utility communications systems, the reasons why the arguments are no longer valid today, the problems that arise where interconnections are made for even non-critical applications, the restrictive and non-uniform practices exercised by the common carriers at various points across Canada, and a brief summary of the reasons why utilities must own and operate their wholly owned and specialized communications systems, which constitute an integral part of the high voltage power system.

It is a fair statement to make, that Canada is probably blessed with the finest public telephone facilities in the world. With all due modesty one may make the same claim for the electrical utilities of our country. However, it is also fair to state, that the communications plant designed to handle public telephone traffic does not in any way, constitute the optimum design or medium for handling all of the major communications requirements of an electrical utility.

There are, and there always will continue to be, certain non-critical applications where it is to the mutual advantage of both parties to establish an interconnection of the two systems. A new, fresh approach is required in defining the ground rules

for establishment of these interconnections without reference to historical traditions, but based rather on a cooperative, objective, economic engineering approach and one which is uniform across the country.

USER: DEPARTMENT OF TRANSPORT (DOT)
Ottawa, Ontario

1. DOT operates a number of services for specific requirements classified as follows:

- Air and Marine Traffic Control
- Radio Aids to Air and Marine Navigation
- Meteorological
- International and Domestic Air-ground Communications

2. The major portions of the DOT systems are leased from common carriers, while the remainder is owned and maintained by the Department.

3. There is interconnection between DOT operated systems and common carriers switched public telephone network for the following purposes:

- Air Traffic Control
- Marine Traffic Control
- Air to Ground Communications
- Ship to Shore Communications

For the last one, the role of DOT is similar to that of a common carrier and public service is offered when required.

4. Where interconnection is involved, DOT circuits and interface equipment are engineered to meet common carrier standards.

5. In spite of good working relations with DOT, common carriers do not always agree to provide facilities for public circuit interconnection to meet the Department's special needs. To quote an

instance, for operational convenience and economy, DOT has recently embarked on a program to remotely monitor the functions of its 287 lighthouses from convenient central locations. At most of these locations there are no reliable communication services and DOT is considering the installation of its own communication network to points where common carrier facilities are available and then route the information via the public switched network. The implementation of this program is held up since both Bell Canada and B. C. Telephone, who control most of the interconnection locations, have so far declined to agree to the required interconnection or any effective alternative.

6. For pollution control in the Lake Erie area DOT has proposed setting up an air patrol using VHF equipment and frequency synthesizer in one of its aircraft. The object is to detect and report any oil patches and probable offenders as and when necessary. To achieve an operational air to ground system DOT needs interconnection with Bell Canada VHF mobile base stations located along Lake Erie. Bell Canada has been approached on this matter in late 1969 but no satisfactory response has yet been received.

USER: FORD MOTOR COMPANY LIMITED
Oakville, Ontario

Ford Motor Company, like other large corporations, makes extensive use of communication for data on sales, ordering, production, flow of materials, etc. The following communication systems are in use:

Intercommunication System

This privately owned system, installed at Ford headquarters about 20 years ago, is still providing a good and reliable service. The maintenance is supplemented by a periodic system check by the manufacturer's representative. The intercom system is extended to the main plant about half a mile away via a Bell Canada cable but there is no interconnection with the switched public network.

VHF, UHF Radio System

This mobile radio system is used for the control of Ford vehicles operating in the plant area. Though this is a minor aspect of the company's business, reliable and continuous communication is considered essential for the continuity of work and the safety of men and materials.

Private Line and Computer Input Circuits

Private line circuits are leased from common carriers to form the bookkeeping and logistics network of the company.

Orders from dealers are sent to regional offices. The regional offices are connected by private line to Oakville. Here

the orders are received, sorted and routed by computer to the appropriate plant where this data is the basis of the production schedule. Orders for models not produced in Canada are automatically routed to Detroit.

The Ford operation for receiving and storing of parts, components and materials is tightly scheduled. Hence good communications is essential.

To achieve effective control over the entire operation, various suppliers and shippers are also linked to Ford headquarters by means of Telex and TWX.

Ford has private lines leased from both the telephone and railway common carriers but has no major requirements for interconnection of these circuits with each other or with the public switched telephone network.

USER: HOTEL ASSOCIATION OF CANADA

1. The hotelmen of Canada have been concerned for many years with the rising costs of their telephone departments and would like to see changes made which would provide relief in several areas.

2. The Hotel Association of Canada presented a brief to the Canadian Transport Commission in February, 1969. At that time the brief was submitted on behalf of about 3,500 hotels in Canada, and its purpose was to oppose the policy in respect to charges being made by the Bell Telephone Company in Eastern Canada, as well as to voice protest against the request of that company to obtain higher rates for certain services.

3. The major areas of complaint are as follows:

- The hotel industry, does a great deal of work on behalf of telephone companies without receiving adequate compensation.
- Hotels are charged a higher rate for extension service than private residences. Hotels feel that since they provide accommodation comparable to private residence, they should not have to pay more than the average householder does for private line service for its guests.
- There does not appear to be any consistency in some provinces in the contracts made between the hotels and the telephone companies. In some cases there are no contracts

but just a letter of intent to cover the equipment installed in the hotels, and these letters of intent differ widely from one area to another.

- Many hotels have paid rental charges on the same PBX as originally installed with no suggestion that it be removed and more modern equipment substituted. This applies in many instances to the telephones in the bedrooms.
- When a telephone directory is destroyed or taken away from a pay-booth, a new one is installed in its place. Some hotels are made to pay 75¢ for each additional copy to replace those destroyed or taken from a bedroom.

4. To ease the present burden of losses which the hotel industry is continuously sustaining, the Association feels that in addition to taking steps to redress the above grievances the following changes should also be considered:

- A choice to either purchase or lease equipment other than from the telephone company if better terms can be arranged.
- Telephone operators paid for by the telephone company to offset the unrecoverable cost* borne by hotels through telephone service.
- A commission of 15 percent on outgoing paid calls and incoming collect calls and a commission of 15¢ for each credit card call and each outgoing collect call and third-party charges.

* Hotel guests are normally charged between 15¢ and 50¢ for each local telephone call made from hotel rooms.

HOTEL ASSOCIATION OF CANADA
INCORPORATED
AFFILIATED WITH THE INTERNATIONAL HOTEL ASSOCIATION • INTER-AMERICAN HOTEL ASSOCIATION
OFFICIAL DIRECTORY: "WRIGLEY'S HOTEL DIRECTORY"

Hotels claim Bell charging too much

By TERENCE BELFORD

The Hotel Association of Canada says it is subsidizing the operations of Bell Canada in hotels and plans to ask the Canadian Transport Commission to end this practice. The CTC will convene to hear Bell's application for increased rates and tariffs May 20.

In a brief tabled yesterday the association, which represents about 3,500 Canadian hotels and motels, includes an example of the subsidization.

A survey of the telephone departmental operations of 42 Canadian hotels show that the hotels lost $772,000 on telephone sales of $3.322,000 in 1968. This compares with a loss of $616,000 on sales of $3,094.000 in 1967 and $476.000 on sales of $2,798,000 in 1966.

The average loss on telephone service for each available room was $46.42 in 1968. In Ontario the loss was $52.46, compared with $46.55 in Quebec and $37.83 in all other provinces.

Bell Canada charges 5 cents for an outgoing call and has asked this be increased to 10. It charges the hotel a monthly rental on equipment to handle incoming and outgoing calls and the hotel provides staff to handle the equipment.

The brief says Bell must prove it needs the rates increase and, in the association's opinion, there is not enough evidence presented by Bell to arrive at reasonable rates.

It adds that the burden of proof should also rest with Bell in the matter of charges to hotels.

According to the association, it should not have to pay more than the average householder does for private line service for its guests.

"Hotels are charged a higher rate for extension service than private residences . . . This contributes to the unrecoverable costs borne by hotels. Accordingly, Bell Canada is indirectly subsidized by hotels to the extent of such unrecoverable cost resulting in undue discrimination against hotels."

The submission says Bell does not equitably distribute revenue requirements through various classes of service. The value of service to a residence customer is as great as the value of service to a business customer. Bell has not weighed its objectives and effected a balance among them.

Hotels want the same status as private residences as far as telephone charges go, the association says.

Provision of telephone service to hotels and to hotel guests should be compared to the same rate structure as charged to residences since hotels provide accommodation comparable to private residences.

"The method of charging for calls on a per-message basis and the administration thereof by hotels is unjust and unreasonable."

The association feels it should receive an equitable commission on long distance calls and receive indemnity for uncollectible charges.

In addition, the hotels want:

—A choice to either purchase or lease equipment other than from Bell Canada if better terms can be arranged.

—Telephone operators paid for by Bell to offset the unrecoverable cost borne by hotels through telephone services.

—A commission of 15 per cent on outgoing paid calls and incoming collect calls and a commission of 15 cents for each credit card call and each outgoing collect call and third-party charges.

The brief follows one filed in March that did not offer Canadian figures but suggested that U.S. industry-wide losses absorbed by hotels amount to $25-million annually.

USER: HYDRO-QUEBEC
75 Dorchester Boulevard West,
Montreal 128, P.Q.

1. Hydro-Quebec has had its own telecommunications system for more than 30 years and installed its first microwave system about 15 years ago, as among other things, it was also the most economical solution to a major communications problem.

2. In the opinion of Hydro-Quebec, microwave and associated telecommunications systems carrying information necessary for the operation, control and protection of the power system form an integral part of the power network and should therefore be under direct control of the Hydro authority so that the required reliability and security can be maintained. The Hydro-Quebec microwave system, in addition to being used mainly for power system operation and protection, also carries administrative circuits.

3. No general interconnection facilities exist between the Hydro-Quebec telecommunications system and the public telephone network. Such interconnections are not favoured and are looked upon as leading to a lowering of system security and reliability. If "interconnection" is possible in the future, Hydro-Quebec would like to see "freedom-of-choice" available so that they could install the arrangement ("privately" owned or "interconnection") best suited to their particular requirements.

4. As a special case, at Rouyn, a few Hydro-Quebec telephone circuits have been made available (free-of-charge) to Northern

Telephone to extend public telephone service to generating stations and sub-stations in this area. In addition, during the construction stage of the Manicouagan Project, (Outardes 3, Outardes 4, Manic 2 and Manic 5) Hydro-Quebec is leasing approximately 40 voice circuits to Quebec Telephone at inter-telephone company rates so that public telephone including pay-phone service could be installed in the construction area catering to about 2,000-3,000 construction workers. It is understood that after the construction phase, Hydro-Quebec will allow Quebec Telephone to retain a few circuits (free-of-charge) in order to extend public telephone service to the new hydro stations. These telephones would be treated as local extensions of the Quebec Telephone Baie Comeau exchange.

5. Hydro-Quebec headquarters in Montreal has approximately 2,000 telephones and forms the nerve centre of the entire power system operation. DDD facilities connecting 35 regional offices are available. All power generating stations and sub-stations are equipped with public telephones. At the Montreal headquarters two large and separate exchanges are installed - one is dedicated exclusively to the Hydro system and the other to the public network.

6. Inter-company interconnection with the New Brunswick Electric Power Commission is made via power line carrier. This medium is also used to provide interconnection with Alcan by means of their Saguenay PBX.

USER: IBM Canada Ltd.
Don Mills, Ontario

1. IBM has a large leased telecommunication network for administrative and data processing purposes. Twenty-three IBM Datacentres from Victoria to St. John's are linked by common carrier telecommunication facilities. The networks are entirely composed of circuits provided by telephone companies and CN-CP Telecommunications.

2. The network has grown at a rapid rate over the past few years.

3. The IBM Datacentre offers a wide range of remote data processing services available from a number of locations in Canada.

4. For remote data processing services the customer, through a terminal in his office, can communicate directly with the desired computer via a public or leased telecommunication link.

5. In some cases the customer does not have much freedom in choosing the communication facilities for certain remote data processing services since the carriers will not allow interconnection of their telecommunication services. In this environment the customer may not be able to obtain the most efficient and economical service depending upon his existing network facilities.

6. Interconnection, by using privately-owned equipment, of telecommunication carriers' leased line services with switched services, and interconnection between these services and privately-owned telecommunication facilities would be helpful in encouraging expansion and new developments of data processing applications

and services. Users of data processing would benefit from the expansion of applications and economies which would result.

IBM recognizes the importance of maintaining the integrity of the telecommunication carrier's system. IBM believes, however, that a more liberal policy toward interconnection should be considered and that suitable technical specifications can be determined to permit this.

USER: INTERPROVINCIAL PIPE LINE COMPANY
10015 103rd Avenue
Edmonton, Alberta.

1. Interprovincial Pipe Line Company and its U.S. subsidiary, Lakehead Pipe Line Company, operate a multiple system of 5,100 miles of pipeline from Edmonton to Toronto and Buffalo, N.Y. The majority of the pump stations are controlled from Edmonton with the assistance of a central on-line System 360 computer. All pump stations thus controlled are equipped with PDP-8S computers.

2. The operation of the pipeline is controlled via a leased telephone and data network provided by AGT. The system basically consists of:

a) One 300 baud data circuit for data transmission

b) One party line teleprinter circuit

c) One broadband party line data channel currently being used for voice transmission.

d) Public telephone service to all pipeline stations.

3. The service provided by AGT is considered satisfactory though problems do exist to bring about fast, coordinated reaction from the various participating telephone companies, particularly those in the U.S. section of the pipeline, during system failures or faults. Overall reliability is claimed to be 97%.

Lease rate on the Canadian portion of the circuit is approximately $4.00 per month for voice grade circuits.

4. There is no interconnection between the leased circuits and

the public systems and Interprovincial does not want this type of interconnection at present.

5. AGT has intimated to Interprovincial that the latter can use its own data modem (Spec. by AGT) though AGT will carry out installation and interconnection.

USER: ONTARIO HYDRO
480 University Avenue
Toronto

1. Ontario Hydro has leased a large complex of telephone circuits and associated equipment mainly from Bell Canada to meet all of its administrative communication needs (Bell Canada-Hydro agreement is based on 30-day termination).

2. A frequency diversity microwave radio system is now under construction to be used primarily for power system protection and control. Barring a few operational voice channels no other voice circuits are contemplated.

3. Some power line carrier telephone circuits exist but these are gradually being phased out in areas being served by microwave radio.

4. By special agreement with Bell Canada, Ontario Hydro can dial out over the leased circuits to the public exchange. However incoming calls from outside are barred from access to the leased channels.

5. Power line carrier telephone circuits and leased circuits are terminated at the same PBX and Bell Canada has agreed to allow Ontario Hydro to interconnect these private circuits with the public network under emergency conditions via associated PBX.

6. Ontario Hydro is reasonably satisfied with the administrative telephone service it gets from Bell Canada, both in terms of

quality and reliability and has no present plans to replace existing leased facilities with its own communications system.

7. Points of interconnection with other utilities are:

Manitoba	-	Seven Sisters Generating Station	
Quebec	-	Beauharnois Masson Val Tetreau Paugan	Bryson Rouyn Kipawa Rapide des Iles
U.S.A.	-	Niagara Falls,N.Y. Lewiston, N.Y. Massena, N.Y.	Detroit, Mich. Marysville, Mich. St. Clair, Mich.

THIS SERVICE AND INTERCONNECTION AGREEMENT

made in duplicate the 1st day of January 1967.

BETWEEN:

THE BELL TELEPHONE COMPANY OF CANADA

hereinafter called "the Telephone Company"

OF THE FIRST PART

- and -

THE HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO

hereinafter called "the Power Commission"

OF THE SECOND PART

WHEREAS the parties hereto entered into an Agreement dated the 25 day of November, 1952 whereby the Telephone Company agreed to provide services and facilities to the Power Commission for its communications needs and also to interconnect certain facilities of the Power Commission with the facilities of the Telephone Company; and

WHEREAS the said Agreement has been extended from its formal expiry date by mutual agreement, as evidenced by correspondence dated the 9 day of October and the 11 day of October, 1957; and

WHEREAS the communication services and facilities listed in Schedule A of the aforesaid Agreement have been substantially

retired or disposed of; and

WHEREAS the parties hereto desire to enter into a new Agreement superseding and replacing the existing Agreement as extended as foresaid; and

WHEREAS the Power Commission undertaking includes the operation of stations and power lines which may be erected on properties between or beyond the areas served by the exchanges operated by the Telephone Company; and

WHEREAS interruptions in the continuity of the Power Commission's operations may endanger the public welfare and safety; and

WHEREAS satisfactory communication services and protection and control circuits are essential for the Power Commission's operations and also for the prompt restoration thereof in the event of breakdown; and

WHEREAS the Power Commission intends to continue to secure the bulk of its communication services and certain of its protection and control circuits from the Telephone Company and desires to interconnect certain of its facilities with facilities of the Telephone Company; and

WHEREAS the Power Commission has established and will continue to extend, operate and maintain, a supplementary network of communication services, hereinafter in this Agreement referred to as "the Supplementary Network", to provide diversity between locations where temporary interruptions of the service

being provided on Telephone Company facilities would cause a serious disruption to Power Commission operations;

WITNESSETH that in consideration of the terms, conditions and agreements hereinafter contained, the parties hereto mutually agree as follows:

1. In this Agreement:

"Communication services" mean telephone communication services for transmitting messages between persons, and

"Protection and control circuits" means circuits utilized for the purpose of providing protection to, control of, or information pertaining to the operation of, the Power Commission's works, whether the terminal equipment is automatic or manually-operated.

2. The Telephone Company, within the operating territory within which it now provides or may hereafter provide communication services to the public, will furnish, install and maintain, communication services and protection and control circuits as requested by the Power Commission for use in the operation of its undertaking, which may include the provision of such services and circuits from or to a point on a right-of-way, or a station, outside the aforesaid operating territory, upon and subject to the terms and conditions, rates and charges contained in the Telephone Company's tariffs from time to time established and in force, except where there is no applicable tariff, in which case the terms and conditions, rates and charges shall be established by negotiation with the Power Commission and shall

generally be equivalent to those rates and charges applicable to other customers securing similar services from the Telephone Company; provided that the services and facilities supplied shall meet or exceed the generally accepted current practices of the telephone industry in respect to noise, band width, and transmission level.

3. Where the Power Commission maintains and operates a supplementary network or any other communication services, the Telephone Company shall interconnect such network or services with Telephone Company terminal equipment, by means of channel facilities, which shall be provided by the Telephone Company, extending from a terminal of the Power Commission's circuits, within or near a telephone exchange or local service area, to the Telephone Company's said terminal equipment within an exchange or local service area, provided that where connection is required into the general telephone network, clauses 8 and 9 will apply.

4. Where the Power Commission is providing its own protection and control facilities, circuits in such facilities may be utilized as voice circuits for part of the Power Commission's supplementary network and shall be interconnected with the Telephone Company's terminal equipment in accordance with clause 3.

5. Where protection and control circuits are provided by the Telephone Company, the required terminal equipment will be provided by the Power Commission unless otherwise agreed upon by the parties hereto.

6. Where the Power Commission desires interconnection of the communication services and protection and control circuits, provided by the Telephone Company pursuant to clause 2, with terminal equipment of the Power Commission, such interconnection shall be made in accordance with mutual agreement between the Power Commission and the Telephone Company.

7. Communication services provided by the Telephone Company in accordance with clause 2, and connected with facilities of the Power Commission, shall be made available by the Power Commission, only to its own personnel or to persons using such facilities for Power Commission business.

8. The supplementary network and any other communication services derived from equipment provided by the Power Commission, may be used by the Power Commission in conjunction with facilities of the Telephone Company, for connection into the general telephone network, subject to the provisions of paragraphs (a) and (b) below:

(a) Facilities of the Power Commission that meet the generally accepted current practices of the telephone industry with respect to noise, band width, and transmission level, may be so used, while other facilities of the Power Commission may be so used only in cases of emergency involving safety of life or property;

(b) When the facilities of the Power Commission are con-

nected to the Telephone Company's general network, they will not at the same time be connected elsewhere to the privately-owned communications facilities of others, except where such connection is made for the conduct of Power Commission business, or in cases of emergency involving safety of life or property, and the Power Commission will take such measures as in its opinion are effective to restrict such connections as aforesaid.

9. The Telephone Company assumes no responsibility for the quality of service nor for failure of transmission from any cause whatsoever resulting from the emergency conditions referred to in paragraphs (a) and (b) of clause 8 above.

10. Facilities of the Power Commission connected with facilities provided by the Telephone Company will be so constructed, maintained and operated as to work satisfactorily with the facilities of the Telephone Company, and each party hereto will take all reasonable precautions to ensure that its circuits which may be connected pursuant to this Agreement will not cause hazard to any person or property; upon written notice by either party that circuits of the other party cause or are likely to cause such hazard, the other party at its own expense will promptly make such changes in its facilities so connected as are reasonably necessary to remove the hazard.

11. Where either party deems special protection devices to

be necessary, such devices as are approved by both parties shall be installed and maintained by one of the parites hereto. Where, at the request of either party, additional expense over and above normal installation and maintenance cost is incurred by the other party in so doing, such additional expense shall be apportioned between the parties hereto in accordance with mutual agreement reached between them.

12. As of the 1 day of January, 1967 this Agreement shall supersede and replace the aforesaid Agreement dated the 25 day of November, 1952 as extended by letters dated the 9th day of October and the 11 day of October, 1957 and shall continue in force and effect for an original period of five years from the 1 day of January, 1967 and thereafter from year to year unless and until terminated by either party upon six (6) months written notice to the other prior to the end of said original period, or any such yearly period.

USER: TRANS MOUNTAIN OIL PIPE LINE COMPANY
400 East Broadway
Vancouver, B. C.

1. Trans Mountain Oil Pipe Line Company uses a communications system for its pipe line operation which is entirely leased. Existing facilities include:

a) A high grade voice circuit consisting of a microwave channel.

b) 300 baud party line data circuits operating at 150 baud for digital telemetering and digital remote control.

c) Full voice channels for multiplexed analog telemetering and control.

d) Private wire teleprinter circuit.

e) D. C. loop telegraph circuits.

f) Telex facilities.

Annual rental for the above dispatch, control and telemetering facilities is in the order of $100,000.

2. Communications required for administrative and maintenance functions are carried out via the public telephone network, telex, private wire teleprinter or VHF radio facilities. All pump stations, administrative centres, maintenance centres and central warehouse facilities are provided with separate telephones, teleprinters and/or VHF radio facilities for this purpose.

3. The private line circuits are leased from the common communications carriers as shown below:

a)	Edmonton-Edson-Jasper-Kamloops-Sumas-Vancouver (Voice Dispatch)	CNR Microwave
b)	Edmonton-Gainford (Telemetering and Control)	CNT
c)	Niton-Edson-Jasper-Red Pass (Telemetering and Control)	AGT
d)	Albreda-Blue River-Black Pool-Kamloops-Kingsvale (Telemetering and Control	BCT
e)	Hope-Chilliwack-Sumas (Telemetering)	CNT
f)	Sumas-Sumas Mountain (Telemetering and Control)	BCT
g)	Sumas-Laurel (U.S.) (Telemetering and Control)	BCT
h)	Vancouver-Sumas (Telemetering)	CNT
i)	Vancouver-Burnaby-Sumas-Laurel-Ferndale-Anacortes (private Line Teleprinter)	BCT

4. There is no interconnection between the leased systems and the public switched networks and in the pipe line company's point of view such an interconnection is not necessary.

5. It is understood that Trans Mountain has only minor difficulties with regard to the telephone companies and the leased facilities.

APPENDIX B

CARRIERS

CARRIER: CANADIAN NATIONAL-CANADIAN PACIFIC TELECOMMUNICATIONS

1. With the exception of Newfoundland, Yukon and Northwest Territories, CN-CP does not provide switched telephone service to the general public. Excluding Telex services, its role in other provinces resembles that of an entrepreneurial system, offering telecommunication services for hire.

2. CN-CP has already established a 960 voice channel capacity microwave network mainly intended for data transmission. Circuits derived from this network are presently used at speeds up to 4,800 baud in our broadband switching service. Fifty percent of broadband circuits provide voice communication capabilities in terms of hot lines, conferences, rapid dialling, broadcast facilities, etc.

3. There is not general interconnection facilities between CN-CP and the public telephone networks. However, on the basis of a past agreement interconnection facilities are available for a limited number of CN-CP circuits for intra-company usage.

4. CN-CP is currently negotiating with TCTS to establish a general interconnection agreement between the CP railway network and the Bell switched network. So far the negotiations have not been fruitful. As interconnection facilities do not exist between the CN-CP broadband and the telephone companies' local telephone switching system, difficulties are often experienced in selling broadband service to the customer.

5. With regard to interconnection between the railways and private systems, CN-CP will allow such interconnections with the reservations that

a) CN-CP will not be responsible for the operation and performance standards of the private systems if affected by interconnection.

b) Private systems should in no way interfere with other circuits carried by the CN-CP network.

c) CN-CP will have the right to disconnect any interconnected private system without any notice if, in the carriers' opinion, the private system is considered to be degrading the performance of the CN-CP network.

CARRIER: NORCOM TELECOMMUNICATIONS LIMITED
Kenora, Ontario

1. In the early 1950s a small private company (Norwesto Communications Kenora Ontario) started operation in North Western Ontario providing telephone services to a large number of fishing, hunting and mining establishments from Kenora as far north as Hudson's Bay, pioneering the use of transportable HF and VHF radio equipment in that area. The central facilities in and around Kenora were interconnected with the Northern Telephone system which provided long distance trunk service throughout Northern Ontario. Norwesto later merged with Northern Telephones.

2. Subsequently in the early 1960s under the same management and ownership as Norwesto, Norcom Telecommunications Limited was formed and incorporated by Federal Charter. Norcom owned and operated a private microwave network connecting the major centres in North Western Ontario (Fort Frances, Atikokan, Kenora, Dryden, Red Lake) carrying telephone channels between these centres under contract with Northern Telephones Ltd., and television under contract with the CBC. For TV the network was interconnected with the transcontinental CN-CP microwave system which carried the CBC program from Winnipeg to the interconnection point (private line service). For telephones the Norcom network was interconnected at many places with the

Northern Telephone trunk line system (public switched network) which in turn was interconnected with the municipal telephone systems of the various centres.

3. The Norcom network did not carry any traffic of its own, except for maintenance channels. It was therefore a pure form of "entrepreneurial system" based on the concept of carrying TV and a relatively small amount of telephone traffic on one and the same system. Thereby it was possible to offer services at a price substantially below that which was being asked by the common carriers for providing the services separately on common carrier facilities. Without the concept of combining traffic it would have been many years before the CBC could have afforded TV service in locations such as Red Lake and Atikokan, and it would also have taken much longer before those communities were provided telephone service to the extent and quality available by microwave links.

4. After Norcom had been in successful operation for several years control of Northern Telephones Ltd. passed to Bell Canada and subsequently in 1968 Bell bought the Norcom microwave system which it still operates. Norcom itself is now working in the cable television field.

5. All interconnection arrangements were worked out directly between Norcom and the common carriers (Northern Telephones for telephony, and CN-CP for television) and no difficulties were encountered in this respect.

CARRIER: PAGETTE AIR SIGNALS LIMITED
Toronto, Ontario

1. Pagette Air Signal Limited is a Restricted Common Carrier (RCC) operator which provides radio paging service and radio land mobile service to a wide cross-section of private users across Canada.

2. The paging system uses either one-way tone paging or voice paging, of which the latter is more popular. A home office wishing to contact a field representative calls the central paging office and identifies his party by code number. The operator pages either by tone or voice (in which case a message can be delivered). The paged party then communicates with his home office via the normal telephone system.

3. Paging systems using dial access interconnection through the public switched telephone network to paging units in the field, and employing a 20-second time element cut-off to prevent holding the system, are in use in the United States. Pagette Air Signals Limited is in favour of this type of interconnection if an appropriate policy were established for their use through government and the common carriers. The only apparent danger to overloading the system exists if the individual reveals his page number indiscriminately. This is considered a matter of company or personal discipline. It is not a consideration in the present configuration since the central paging operator responds only to dedicated callers.

4. Regarding the radio land mobile service the company is interested in an acoustically coupled patching system which would allow the operator access to the public telephone system without actual physical connection. The acoustically coupled patching system would be as an option to the physical interconnection which is the better method.

CARRIER: TRANS-CANADA TELEPHONE SYSTEM

The following paragraphs contain the request for information and the response made by TCTS. Because policies are individual to particular companies and vary across the country, no response has been provided in certain cases.

1. TCTS policy regarding interconnection of switched telephone network with

   a) private telephone systems (owned or leased)
   b) private teletype and data sets
   c) computers
   d) private voice frequency equipment.

   a) Private Telephone Systems

   Customer provided (leased or owned) systems are not generally permitted access to the switched telephone network. Policy allows for exceptions to this provision for certain economic and or public interest reasons.

   b) Private Teletype

   Customer owned devices of this type are permitted access to the switched telephone network via a telephone company provided interface. Terms and conditions are covered in detail in material submitted to the Telecommission Study 8 (b) (iii).

   c) Computers

   Access to computers from customer provided terminals, via the general switched network is accommodated by TCTS policy

under terms and conditions which are detailed in material submitted to the Telecommission Study 8 (b) (iii).

d) Voice Frequency Equipment

This category is broad in scope. Voice frequency equipment functioning in a terminal mode is covered under the policy applying to devices. (See b) and c) above.) These equipments functioning as an integral part of a system would be treated under policy applying to systems (1a). For example, multiplexers functioning on a point-to-point, private line system, with no network access are permitted. However, multiplexers functioning within a system which is accessed over the general switched network so that they become an integral part of the switched network capability and design will be provided by the telephone company.

2. TCTS policy regarding interconnection between

a) a privately owned telephone system

b) broadband interconnection (TV and data) between a privately owned system and a leased system.

c) broadband interconnection between two or more leased systems (possibly leased from different carriers).

a) Privately Owned Telephone Systems

Systems such as PBX's will be interconnected by facilities of the T.C.T.S. Companies between the same user or different users,

provided there is no access to the switched telephone network. Carrier systems owned by or leased by customers will not be interconnected under current policy to the facilities or equipment of the telephone companies. Policy in this regard allows for exceptions which are determined on a case by case basis. Private systems constructed by right-of-way companies serving their own needs in remote areas, and public service organizations such as police, fire, broadcasters, etc., are typical of those special situations that dictate the public interest is best served by interconnecting a private system.

b) Broadband Interconnection TV and Data Between a Privately-owned System and a Leased System

TCTS companies will interconnect their facilities to those of a TV network operator. Data interconnection would be treated on a case by case basis.

c) Broadband Interconnection Between Two or More Leased Systems (possibly leased from different carriers)

Regarding switched data broadband interconnect, the TCTS companies do not offer such a service at this time. Regarding private line broadband interconnection, the policy is the same as that pertaining to today's private line services.

3. TCTS opinion and reaction regarding interconnection between two or more privately owned systems.*

No response provided.

* Refer to official T.C.T.S. submission on Telecommission Study 8 (b)(i), Section A, page 8, attached.

4. TCTS policy regarding multiplexing a number of data channels on a leased telephone channel using user's own equipment meeting TCTS required specifications.

   TCTS companies permit users to supply their own multiplexing facility on voice grade private line systems. Multiplexing of the switched network has been maintained as a function of the carriers.

5. TCTS policy regarding amateur radio operator's practice of patching circuits via telephone handset.

   Patching of radio systems by any radio operator to the switched telephone network is not generally permitted.

6. TCTS policy regarding interconnection between public switched networks with emergency private systems used by services like police, fire, hospital, etc. (both fixed and mobiles). *

   No response provided.

7. Comments and details of interconnection facilities made available to major private users like Alcan and Ontario Hydro.

   Special agreements with power companies such as Ontario Hydro, and Alcan in B.C., are discussed in the response to question 2 a).

   When right-of-way companies serving remote areas, provide their own communications facility and it is not economical for the carrier to duplicate the facility, interconnection agreements are established. Additionally, requests from public service agencies such as the government, broadcasters, military, police and fire, etc. have been accommodated by interconnection agreements when it has been in the public's best interest to do so.

* Refer to official T.C.T.S. submission on Telecommission Study 8 (b)(i), Section A, page 8, attached.

8. a) TCTS telecommunication rates and tariffs for public and private telecommunication services (including broadband).

Rates for public and private services including Telpak are attached.

b) A resume of the basis used to develop rates and tariffs for given systems.

In developing rates for quotation to a customer a salesman determines the airline mileage between the terminating points and locates the applicable charges on the attached rate schedules for quotation.

Details of rate making procedures will be discussed in detail in Telecommission Study 7 (a), (b).

TWO-POINT SERVICE

RATES - Typical Trans-Canada Schedule

CLASS OF SERVICE		STATION-TO-STATION						PERSON-TO-PERSON			
		Day		Night and Sunday		Late Night (w)		Day		Night and Sunday	
RATE DISTANCE (MILES)		Weekday 6:00 a.m. to 6:00 p.m.		Weekday 6:00 p.m. to 6:00 a.m. and Sunday		Every day Midnight to 6:00 a.m.		Weekday 6:00 a.m. to 6:00 p.m.		Weekday 6:00 p.m. to 6:00 a.m. and Sunday	
Over	Up to and Including	Initial 3 Minutes	Each Additional Minute	Initial 3 Minutes	Each Additional Minute	Initial 3 Minutes	Each Additional Minute	Initial 3 Minutes	Each Additional Minute	Initial 3 Minutes	Each Additional Minute
0	8	$ .10	$ .05(x)	$ .10	$ .05(x)	$ .10	$ .05(x)	$ .30	$ .05	$ .30	$ .05
8	12	.15	.05	.15	.05	.15	.05	.35	.05	.35	.05
12	16	.20	.05	.20	.05	.20	.05	.40	.05	.40	.05
16	20	.25	.05	.25	.05	.25	.05	.45	.05	.45	.05
20	25	.30	.10	.30	.10	.30	.10	.50	.10	.50	.10
23	30	.35	.10	.35	.10	.35	.10	.55	.10	.55	.10
30	36	.40	.10	.35	.10	.35	.10	.65	.10	.60	.10
36	42	.45	.15	.35	.10	.35	.10	.70	.15	.65	.10
42	43	.50	.15	.40	.10	.40	.10	.80	.15	.70	.10
43	56	.55	.15	.45	.15	.45	.15	.85	.15	.75	.15
55	64	.60	.20	.45	.15	.45	.15	.95	.20	.80	.15
64	72	.65	.20	.50	.15	.50	.15	1.00	.20	.85	.15
72	80	.70	.20	.55	.15	.55	.15	1.10	.20	.95	.15
80	90	.75	.25	.55	.15	.55	.15	1.15	.25	1.00	.15
90	100	.80	.25	.60	.20	.55	.15	1.25	.25	1.05	.20
100	110	.85	.25	.65	.20	.55	.15	1.30	.25	1.10	.20
110	120	.90	.30	.65	.20	.60	.20	1.40	.30	1.15	.20
120	132	.95	.30	.70	.20	.60	.20	1.45	.30	1.20	.20
132	144	1.00	.30	.75	.25	.60	.20	1.55	.30	1.30	.25
144	156	1.05	.35	.80	.25	.65	.20	1.60	.35	1.35	.25
155	168	1.10	.35	.85	.25	.65	.20	1.70	.35	1.40	.25
168	180	1.15	.35	.85	.25	.65	.20	1.75	.35	1.45	.25
180	196	1.20	.40	.90	.30	.70	.20	1.85	.40	1.55	.30
196	212	1.25	.40	.95	.30	.70	.20	1.90	.40	1.60	.30

(v) Includes service between Iles de la Madeleine and any other rate centre

(w) Applies only to customer-dialed calls, except, for message toll calls originating or terminating in exchanges in which equipment is not provided that permits customers to dial their own message toll calls or receive customer-dialed message toll calls, these rates apply to those calls that are the equivalent of customer-dialed calls.

(x) Rate is for 2 minutes.

TWO-POINT SERVICE

RATES - Typical Trans-Canada Schedule

CLASS OF SERVICE		STATION-TO-STATION						PERSON-TO-PERSON			
		Day		Night and Sunday		Late Night (w)		Day		Night and Sunday	
RATE DISTANCE (MILES)		Weekday 6:00 a.m. to 6:00 p.m.		Weekday 6:00 p.m. to 6:00 a.m. and Sunday		Every Day Midnight to 6:00 a.m.		Weekday 6:00 a.m. to 6:00 p.m.		Weekday 6:00 p.m. to 6:00 a.m. and Sunday	
Over	Up to and Includ-ing	Init-ial 3 Minu-tes	Each Add-ional Minute	Initial 3 Minutes	Each Additio-nal Minute	Init-ial 3 Minu-tes	Each Additi-onal Minute	Init-ial 3 Minu-tes	Each Addi-tional Minute	Initial 3 Minutes	Each Additional Minute
212	228	$1.30	$ .40	$1.00	$ .30	$ .70	$ .20	$2.00	$ .40	$1.65	$ .30
228	244	1.35	.45	1.05	.35	.75	.25	2.05	.45	1.70	.35
244	260	1.40	.45	1.10	.35	.75	.25	2.15	.45	1.80	.35
260	290	1.45	.45	1.10	.35	.75	.25	2.30	.45	1.95	.35
290	320	1.50	.50	1.15	.35	.80	.25	2.40	.50	2.05	.35
320	360	1.55	.50	1.20	.40	.80	.25	2.55	.50	2.15	.40
360	400	1.60	.50	1.25	.40	.80	.25	2.70	.50	2.30	.40
400	440	1.65	.55	1.30	.40	.85	.25	2.85	.55	2.40	.40
440	480	1.70	.55	1.35	.45	.85	.25	2.95	.55	2.50	.45
430	540	1.75	.55	1.40	.45	.85	.25	3.20	.55	2.70	.45
540	600	1.80	.60	1.45	.45	.90	.30	3.30	.60	2.80	.45
600	630	1.85	.60	1.50	.50	.90	.30	3.45	.60	2.90	.50
630	769	1.95	.65	1.55	.50	.90	.30	3.65	.65	3.10	.50
760	840	2.05	.65	1.60	.50	.95	.30	3.80	.65	3.25	.50
840	920	2.15	.70	1.65	.55	.95	.30	3.95	.70	3.40	.55
920	1000	2.25	.75	1.75	.55	.95	.30	4.10	.75	3.50	.55
1000	1200	2.35	.75	1.80	.60	1.00	.30	4.40	.75	3.70	.60
1200	1450	2.45	.80	1.85	.60	1.00	.30	4.65	.80	3.90	.60
1450	1675	2.55	.85	1.90	.60	1.00	.30	4.85	.85	4.10	.60
1675	1900	2.70	.90	1.95	.65	1.00	.30	5.10	.90	4.30	.65
1900	2200	2.85	.95	1.95	.65	1.00	.30	5.35	.95	4.50	.65
2200		3.00	1.00	1.95	.65	1.00	.30	5.60	1.00	4.70	.65

(v) Includes service between Iles de la Madeleine and any other rate centre

(w) Applies only to customer-dialed calls, except, for message toll calls originating or terminating in exchanges in which equipment is not provided that permits customers to dial their own message toll calls or receive customer-dialed message toll calls, these rates apply to those calls that are the equivalent of customer-dialed calls.

MILEAGE CHARGES

VOICE-GRADE CHANNELS

3. Inter-Exchange Mileage

(b) Monthly Charge

(1) The monthly charge for each channel and for each leg of a multi-point channel

SCHEDULE A 83 Miles or Less						SCHEDULE B Over 83 Miles					
Rate Distance (miles)	Monthly Charge	Rate Distance (Miles)	Monthly Charge	Rate Distance (Miles)	Monthly Charge	Rate Distance (Miles)	Monthly Charge	Rate Distance (Miles)	Monthly Charge (Y)	Rate Distance (Miles)	Monthly Charge (Y)
¼	$1.40	6	$28.70	13	$79.50	84-91	$371.00	587-622	$1774.00	2126-2265	$2942.
½	2.50	6¼	27.80	19	83.90	92-100	394.00	623-680	1848.00	2200-2415	2976.
¾	3.00	6½	28.90	20	88.30	101-110	419.00	681-700	1920.00	2416-2575	3010.
1	4.70	6¾	29.00	21	92.70	111-121	447.00	701-742	1990.00	2576-2745	3041.
1¼	5.80	7	31.10	22	97.10	122-133	478.00	743-786	2058.00	2746-2925	3078.
1½	6.90	7¼	32.30	23	101.50	134-146	512.00	787-832	2124.00	2926-3115	3112.
1¾	8.00	7½	33.30	25	106.90	147-160	549.00	833-880	2188.00	Over 3115	3116.
2	9.10	7¾	34.40	25-26	110.00	161-175	589.00	881-930	2250.00		
2¼	10.20	8	35.50	27-29	119.00	176-191	632.00	931-984	2310.00		
2½	11.30	8¼	36.00	30-32	132.00	192-208	673.00	985-1012	2368.00		
2¾	12.40	8½	37.70	32-35	145.00	209-226	737.00	1043-1104	2424.00		
3	13.50	8¾	38.80	36-33	158.00	227-245	779.00	1105-1170	2478.00		
3¼	14.60	9	39.90	39-41	171.00	246-265	834.00	1171-1240	2530.00		
3½	15.70	9¼	41.00	42-44	185.00	266-286	892.00	1241-1315	2580.00		
3¾	16.80	9½	42.10	45-48	195.00	287-308	953.00	1318-1395	2628.00		
4	17.90	9¾	43.20	40-52	215.00	309-331	1017.00	1396-1480	2674.00		
4¼	19.00	10	44.30	53-56	233.00	332-355	1034.00	1481-1570	2718.00		
4½	20.10	11	48.70	57-60	251.00	356-380	1154.00	1571-1665	2760.00		
4¾	21.20	12	53.10	61-66	268.00	381-406	1227.00	1666-1765	2800.00		
5	22.30	13	57.50	66-70	290.00	407-433	1303.00	1766-1875	2888.00		
5¼	23.40	14	61.90	71-76	312.00	434-461	1381.00	1876-1995	2874.00		
5½	24.50	15	66.30	77-83	330.00(x)	462-490	1481.00	1996-2125	2908.00		
5¾	25.60	16	70.70			491-520	1541.00				
		17	75.10			521-552	1620.00				
						553-580	1695.00				

(x) A maximum monthly charge of $871.00 applies. This maximum monthly charge includes the local channel, as required, in each associated exchange.

(Y) Includes the local channel and drop-service charge, as required in each associated exchange.

TELPAK CHANNELS

RENTALS AND CHARGES

1. Base Capacities

(a) Monthly rentals apply as follows for each mile or remaining fraction:

Telpak A	$25.00
Telpak B	$40.00
Telpak C	$55.00

(b) Monthly rentals apply as follows for each mile or remaining fraction for each additional telephone-grade channel in excess of the base capacity:

Telpak A 1/12 of $25.00
Telpak B 1/24 of $40.00
Telpak C 1/60 of $55.00

2. Duplex Operation

(a) Monthly rentals apply as follows for each mile or remaining fraction for duplex operation on channels within Telpak:

	TELPAK A	TELPAK B	TELPAK C
Voice Grade...............	$0.50	$0.40	$0.25
Over 82.5 bauds up to and including 180 bauds..	$0.14	$0.10	$0.06
Up to and including 82.5 bauds....................	$0.07	$0.05	$0.03

TELPAK CHANNELS

RENTALS AND CHARGES - Continued

3. Channel Terminals

(a) A channel terminal is required for each channel or service arranged for use by the lessee or for each connection of such channel or service to station equipment, or for termination of such channel in a wire centre of the Company to establish a channel for foreign-exchange service. The monthly rental for the exchange service associated with foreign-exchange service is included in the monthly rental for the channel terminal. When a channel-switching arrangement is provided, each station at the switching point requires a channel terminal for each of the services or channels to which it is connected and which can be operated as a separate service or channel. Wideband terminals are charged for as special assemblies of equipment. Rentals for channel terminals other than wideband terminals are as follows:

	Monthly Rental for Each Station in an Exchange, for each Channel Terminal			
	Simplex		Duplex	
	First	Each Additional(x)	First	Each Additional(x)
Telephone	$45.00	$10.00	$55.00	$15.00
Signal, Class A, B and C	45.00	10.00	55.00	15.00
Teletype	45.00	10.00	55.00	15.00
Telephotograph	(y)	(y)	(y)	(y)
Data	45.00	10.00	55.00	15.00
Schedules 1,2&3				
Schedule 4	45.00	10.00	55.00	15.00
Type 4	45.00	10.00	55.00	15.00
Type 4A On a 2-point channel not arranged for switching	55.00	30.00	65.00	35.00
On a 2-point channel arranged for switching or on a multi-point channel	80.00	30.00	90.00	35.00
Type 4B On a 2-point channel not arranged for switching	80.00	35.00	90.00	40.00
On a 2-point channel arranged for switching or on a multi-point channel	105.00	35.00	115.00	40.00

(x) applies to terminals on the same channel or service, except that no rental applies to such additional terminals on the same premises as the first terminal.

(y) Special-assembly of equipment.

TELECOMMISSION STUDY 8b(i)

INTERCONNECTION OF PRIVATE SYSTEMS

Trans-Canada Telephone System July 1970

TABLE OF CONTENTS

TELECOMMISSION STUDY 8b(i): INTERCONNECTION OF PRIVATE SYSTEMS

This study will be divided into six parts as follows:

A. BACKGROUND

B. INTERCONNECTION OF PRIVATE SYSTEMS TO THE PUBLIC TELEPHONE NETWORK

C. INTERCONNECTION OF PRIVATE SYSTEMS WITHOUT NETWORK ACCESS

D. INTERCONNECTION OF PBX (PRIVATE BRANCH EXCHANGES)

E. TECHNICAL ASPECTS OF INTERCONNECTION OF SYSTEMS AND TERMINAL EQUIPMENT

F. NATIONAL ACADEMY OF SCIENCES REPORT - A SUMMARY

Throughout this report, a private system will be considered as any system of facilities, other than those of common carriers, which is capable of two-way communications. Interconnection will be discussed, not only in terms of the effects on Canadian telephone service, but also in terms of the effects on the users of private systems and the attainment of desirable regional and national objectives.

A. BACKGROUND

1. PRIVATE SYSTEMS AND THE EXTENT OF INTERCONNECTION TODAY

a) Private Mobile Radiotelephone Systems

Mobile radiotelephone service is designed to serve customers whose needs cannot be satisfied by landline telephone systems. The telephone companies offer public radiotelephone service which is an extension of the public telephone network. In addition, they provide private mobile radiotelephone systems to customers whose needs do not necessitate connection to the telephone network.

At the present time, there are very few private systems which have access to the public telephone network. The Department of Communications is responsible for the licensing of private mobile radiotelephone systems today. Its predecessor, the Department of Transport, discouraged the general interconnection of mobile radiotelephone systems. Their policy was explicitly stated in a letter to the Western Canada Telecommunications Council on May 12, 1966. An excerpt from that letter is quoted below:

> It was concluded, at least for the present, that the unrestricted connection of private mobile radio systems to general telephone networks would not be consistent with the Department's objectives concerning efficient spectrum management.
>
> On the other hand, it was recognized that in certain special cases such interconnection might be essential to the efficient functioning of certain "safety" services, e.g., police, fire, etc. It was therefore decided to consider proposals of this nature on a case by case basis and to permit interconnection only where the merits of the individual proposal warranted such action.

The Trans-Canada Telephone System members have operated within this framework.

b) <u>Hydro-Electric Power Systems</u>

The hydro authorities and companies in every province, except Newfoundland and Prince Edward Island, have either their own powerline carrier or microwave system. Examples of these are briefly described below:

i) New Brunswick Power Commission - powerline carrier

ii) Hydro-Electric Board (Manitoba) - microwave and powerline carrier.

iii) Calgary Power (Alberta) - microwave

iv) Nova Scotia Light and Power Co./Nova Scotia Power Commission - powerline carrier

v) Saskatchewan Power Corporation - powerline carrier

vi) British Columbia Hydro and Power Authority - microwave

vii) Quebec Hydro Electric Commission - microwave

viii) Hydro Electric Power Commission of Ontario - microwave

These systems are primarily used for highly specialized control functions. However, they also provide voice communication and are capable of transmitting other forms of information. In some provinces they have access to telephone company-supplied PBX's. These arrangements do not generally include public telephone network connection. Similar treatment is extended by special agreement to some other right-of-way companies (i.e., pipelines, and railways) who have specialized communication needs.

c) National Defence Systems

Since 1952, the Department of National Defence and the telephone companies have had an agreement relating to interconnection of DND owned or leased facilities with the public telephone network. The telephone companies agree to interconnect DND owned or leased facilities provided "that the defence of Canada requires connections or interconnections of communications facilities." (Agreement, P.2) The agreement states that DND facilities and equipment must be maintained and protected according to standards approved by the telephone companies. The telephone companies are permitted to inspect facilities for this purpose.

The DND recognized its responsibility to ensure that its circuits are not used "for purposes other than national defence" or "in such a way as to reduce, derogate from or minimize the revenues which the telephone company would receive from its general and/or toll system." In addition, the DND "will, if requested by the Telephone Company, pay... a sum or sums equal to the amount of tolls which the Telephone Company has lost by reason of such improper use." (Agreement, P.6)

d) Other Private Systems

The systems described in this section are simply representative of some of the Canadian private systems.

i) <u>Air Tel</u>

Air Tel is a Toronto based company that is licensed to provide a private microwave system from Windsor to Trois Rivieres. The company provides private mobile radiotelephone systems and paging services to the public. Air Tel has requested network interconnection in the past. However, there has been no interconnection to the public telephone network.

ii) <u>Canadian Western Natural Gas Co. Ltd.</u>

This company owns and maintains its own private line facilities between Lethbridge and Calgary.

iii) <u>Federal Government - National Parks</u>

Circuits owned and maintained by the Federal Government are interconnected at Banff and Jasper with the Alberta Government Telephone facilities through a special switching arrangement.

iv) <u>The Granduc Operating Company</u>

The Granduc Operating Company owns and maintains its own microwave system running from Stewart to Tide Lake, B.C. The system is interconnected with the public telephone network owned by the B.C. Telephone Company at Stewart. In its agreement with B.C. Tel, Granduc is responsible for maintaining its system according to the accepted standards of the Canadian Telephone Industry.

v) Pacific Great Eastern Railway/Quebec North Shore and Labrador Railway

The Pacific Great Eastern Railway in British Columbia and the Quebec North Shore and Labrador Railway both own and maintain large microwave systems which generally follow their rail routes. There is no network interconnection with the PGE. The Quebec railway, however, provides telephone service to several towns along the railway route, and these towns have access to the public telephone network.

vi) Canadian National and Canadian Pacific Railways

The communications systems of the CNR and CPR serve two purposes. They meet the internal communications needs of the railways and they provide facilities for their common carrier operation. A discussion of the TCTS policies pertaining to interconnection of CN/CP common carrier services with those of the telephone companies is contained in our response to Telecommission Study 8b(ii).

The CNR and CPR erected pole lines, mainly adjacent to their rail rights of way, to carry telegraph facilities which were used for internal purposes and for their public telegraph business. Some of the circuits were used for voice communication. To use these voice circuits more efficiently, and for other mutual considerations, the railroad companies and some of the major telephone companies

entered into agreements which permitted CN/CP intercity voice circuits to be terminated on Private Branch Exchange switchboards provided by the telephone companies. These voice facilities were intended for use in the conduct of railroad business only. Over the years, the communications facilities of the railroad companies have expanded greatly, particularly on structures that are not adjacent to rail rights of way.

While, undoubtedly, the majority of traffic carried by these facilities is between CN/CP personnel in the conduct of railroad business, traffic for other than railroad business is possible. Such traffic represents a by-passing of the telephone industries' public message voice service and was not intended in the original agreement. Both CN/CP and the Telcos recognize that this traffic exists today.

If growth is limited on telephone industry structures through interconnection of CN/CP facilities and the subsequent erosion of available voice message services, the telephone companies cannot achieve the optimum benefits of economy of scale. In addition, the introduction of new types of transmission systems will require a large usage base in order to be economically feasible.

The telephone industry is prepared to serve the local and intercity voice requirements of all businesses, including the railroad companies and their subsidiaries on a non-discriminatory basis, by supplying services which have full access to the switched telephone network.

e) Emergency Interconnection of Private Systems

The telephone companies generally permit network interconnection of customer owned and maintained facilities if it is essential to the effective operation of certain agencies providing emergency services to the public. Law enforcement, fire prevention, and railway emergencies are examples of cases where network interconnection has been permitted. Public safety has been the overriding consideration in each case. Existing arrangements are, in most cases, covered by separate agreements. The telephone companies provide the equipment necessary for implementing the arrangement and for protecting the public telephone network.

2. INTERCONNECTION POLICIES IN THE UNITED STATES

The events leading to the liberalized interconnection policy in the United States have been widely publicized. The views of communications suppliers, users and regulatory agencies in that country are well documented. This section will briefly describe the interconnection policies and some industry developments in the United States.

The interconnection policies of the telephone companies in the United States were closely scrutinized during the much-publicized Carterfone case. As a result, the American Telephone and Telegraph Company (AT&T) made significant changes to its interstate tariffs affecting interconnection. Similar changes have been made by the Bell System companies and by many of the Independent Telephone Companies in the U.S.

These tariff revisions represent a major change in the policies of United States telephone companies. The new tariffs permit interconnection of private systems, provided that an interface, designed to safeguard the public telephone network, is incorporated. In addition, provision is made whereby the telephone company will provide entrance facilities into urban centres for private systems.

AT&T has made many minor tariff changes since the original interconnection policies were announced and interconnection continues to be actively discussed in both industry and government. The ultimate economic and technical effects of these policies are still uncertain. In an effort to obtain an objective analysis of the problems, the FCC commissioned the National Academy of Sciences to research the technical aspects of interconnection and its effects on the public telephone system. Their report was published in June, 1970. A summary of this report is contained in Section F.

In July, 1967, President Johnson appointed a Task Force to review U.S. communication policy. The final report (Rostow Report) of this Task Force was issued in December, 1968. This report recommended a greater degree of competition in many communications services and favoured interconnection as long as certain criteria were met. However, this report has not been formally embodied in legislation and continues to be a controversial issue.

The decisions in the United States have increased the demand for interconnection in Canada. This has resulted partly from the wide press coverage given to the U.S. changes. However, a more significant factor has been familiarity with the U.S. situation by Canadian subsidiaries of American firms - both those marketing products for connection to the telephone system and those seeking interconnection of their systems.

There is a clear danger in applying the U.S. interconnection policies to the Canadian situation without fully studying its implications. For this reason alone, it would be wise for Canada to observe the outcome of the interconnection policies in the United States and learn from their experience.

The next sections of this paper will attempt to analyze some of the implications of interconnection in Canada.

B. INTERCONNECTION OF PRIVATE SYSTEMS TO THE PUBLIC TELEPHONE NETWORK

1. ECONOMIC EFFECTS

The implications of interconnecting* private systems to the public telephone network must be viewed with respect to the unique

* For simplicity, the term "interconnection" will be used instead of "network interconnection" unless otherwise stated.

characteristics of the Canadian telecommunications market.

Canada is a large country with a relatively small population. The population is concentrated along the Canada - United States border. As a result, an extremely large investment is needed to serve the basic requirements of underdeveloped areas as well as those of the highly developed major centres. Therefore, in order to obtain reasonable rates, high quality service, and development of communications throughout Canada, it is necessary to use facilities as economically as possible; to avoid duplication of scarce resources; and to ensure that the overall operations of the telephone companies are economically viable.

In order to understand the economic effects of interconnecting private systems, it must be appreciated that a private system is usually a substitute for the services of the telephone companies. Each private system removes a segment of the market since the owner and his employees are, to a degree, no longer customers of the telephone companies. Network interconnection of these systems would automatically increase the degree of substitution for telephone company services.

The unit cost of telephone service decreases with volume in certain areas of operation. This is particularly applicable to intercity transmission facilities. Extensive use of such facilities enables the telephone companies to realize economies of scale which not only reduce the cost of providing intercity service but also provide support for local services which do not experience similar economies of scale. In the past, these

economies of scale have contributed to stabilizing costs and rates during an inflationary period for telephone service and other communications services. These economies of scale will continue to be important in developing economical and reliable communications throughout Canada.

Excessive competition through permissive interconnection policies and a consequent proliferation of private systems, will divide the overall Canadian market for communications. Each time the market is so divided, the opportunity for achieving the optimum scale of operations is reduced. Considering the nature and extent of the Canadian market, the number of competitors does not have to be large before adverse effects become noticeable. The Minister of Communications addressed himself to this problem in his policy statement of February, 1970. This statement is quoted below:

> In recent years, licences for such systems (microwave relays) have been granted mainly on technical grounds even though earlier broader criteria had been applied. However, the growing social and economic importance of this form of telecommunications requires that more attention be placed on other criteria if we are to assure an orderly growth of the Canadian communications system which will assure maximum social benefits and a minimum of wasteful duplication of investment in a field where resources are both scarce and essential to the development of a full potential of all segments of Canadian society. The use of a system's approach in the granting of licences for microwave relays implies that applicants will have to demonstrate:
>
> a) that there is some public interest and need to be served by the creation of the new facility;

b) that existing communications facilities cannot properly satisfy this interest and need; and

c) that the applicant will conform to the standards of service and the technical requirements of the existing network so that the most effective and economical use of the radio spectrum is assured.

The rationale for minimizing interconnection to the telephone network is, we submit, similar to that underlying system licencing.

In general, the regulated telephone companies have accepted the responsibility to serve both higher and lower cost areas. In order to supply service in all areas at reasonable rates, it is necessary for revenue from lower cost areas to help pay for service in higher cost areas. There is little doubt that if unrestricted interconnection is allowed, the demand for new systems will be greatest on the economical high-density routes leaving hard-to-reach areas to the common carriers. This type of "competition" could necessitate reducing rates on high-density routes and raising rates on others. At the present stage of Canadian development, it would seem inadvisable to hinder growth by jeopardizing a rating technique (system-wide pricing) which was designed especially to promote communications service at reasonable rates.

2. TECHNICAL EFFECTS (See Part E)

More detailed discussion of these effects is contained in Part E of this paper. There are many benefits to the user and the supplier of telecommunication services when the control and design of the network and/or systems connected to that network are the responsibility of the common carriers.

The quality of service can be assured only when all interconnected systems are technically compatible and quality standards of equipment are controlled. Consider for a moment what happens when the operation and transmission quality of a private system is different from that of the public telephone network. As long as the system is accessible only to the owner and his employees, then these differences are not important considerations. However, connection of this system to the public telephone network could seriously affect the quality of service supplied to telephone company customers and, in some cases, to the users of the private system.

Fast and efficient maintenance is more likely to result when the technical relationships of all interconnected systems are known. Maintenance becomes more complicated when private systems are interconnected, since different standards and procedures must be co-ordinated. At the present time, maintenance of public systems is the responsibility of the Canadian common carriers. Dispersing this responsibility would seem unwise at a time when new equipment and services are placing even higher demands on the technical integrity of the network.

New technology can be developed and made widely available sooner when the ownership of the total system is not fragmented. The existing common carriers have the resources necessary to apply new technology for the benefit of the total consumer group. The greater the number of interconnected private systems, the more difficult it is to co-ordinate the change from one type of technology to another (e.g., electro-mechanical to electronic switching).

Multiple ownership tends to retard change since, in many cases, equipment must be replaced. The common carriers have worked towards common objectives, thus overcoming the resistance to change which would exist if the control of the system was fragmented.

The cost of providing service to the general body of consumers will be minimized when system ownership is with the common carriers. Engineering design, research and development activity can work to common and known parameters creating cost efficiencies. The training of employees will be shorter in duration and less costly. In addition, the safety of employees and users can be more efficiently supervised and controlled when the characteristics of the overall system are known.

Liberalizing interconnection policies would reduce many of the advantages described above and would require a complicated system of checks and standards. It is doubtful that the majority of consumers would benefit from such policies.

3. ADMINISTRATIVE EFFECTS

An analysis of the administrative effects of interconnection must start from the assumption that all private systems are allowed access to the public telephone network. It is difficult to predict all of the potential problems. Nevertheless, it is obvious that difficulties would exist in defining maintenance responsibilities and in establishing efficient billing and settlement procedures.

Trouble-shooting and repair may create problems especially at the point of interconnection. When troubles arise it is difficult to determine which system has failed. In addition, union difficulties may arise from overlapping labor jurisdictions. The varying technical characteristics of a private system also produce problems where specialized training of maintenance personnel is required. It may be possible to overcome these problems but not without a more complicated and less efficient maintenance arrangement.

The costs and benefits of interconnection must be considered in light of these potential administrative problems. Their importance should not be underestimated.

4. SUMMARY

The Telephone Industry in Canada is reluctant to permit the interconnection of customer provided systems to the public telephone network. This is not to infer that the Industry has not made some special arrangements in this regard. Each company has, in its Tariffs, the freedom to negotiate special agreements where circumstances indicate that such treatment does not jeopardize the economic or technical integrity of the system and is not unreasonably discriminatory.

The Canadian Telephone Industry has studied the advantages and disadvantages of interconnection of private systems from a Canadian viewpoint. The following statements summarize the present thinking of the Trans-Canada Telephone System members:

1. At the present time, the telecommunication common carriers provide good quality, reasonably priced service in Canada. Although interconnection can be technically accommodated, there are important aspects such as cost, quality, speed of innovation, and maintenance which would be jeopardized if existing interconnection policies were radically changed.

2. The economic implications of unrestricted interconnection and the associated effects on common carrier rates appear detrimental to the overall development of communications in Canada.

C. INTERCONNECTION OF PRIVATE TRANSMISSION SYSTEMS WITHOUT NETWORK ACCESS

Interconnecting private transmission systems with private line facilities of the telephone companies extends the area covered by the customer's system. The economic effects of this interconnection depend on the size of the customer-owned network. For example, joining two telephones together with a dedicated private line creates a private system. Extending a privately owned intercity transmission system with facilities of the telephone companies is the same concept only on a greater scale. Both help the customer to by-pass the long distance telephone network.

A prime concern of the Trans-Canada Telephone System is the effect which private systems have on the long distance revenues of the telephone companies and ultimately on the price averaging rating concept, which has contributed greatly to communications development in Canada. The greater the number of private systems, the more serious are the effects. Furthermore, we believe that intercity private systems may unnecessarily duplicate transmission facilities and prevent the achievement of the lowest supply costs for all customers.

However, under current conditions, the members of the TCTS do not generally interconnect transmission systems owned by or leased by customers with the facilities or the equipment of the telephone companies. There are exceptions to this policy which are determined on a case-by-case basis. Private systems constructed by right-of-way companies serving their own needs in remote areas, and public service organizations such as police, fire, broadcasters, etc., are typical of those special situations where the public interest is best served by interconnection.

D. INTERCONNECTION OF PBX's

1. Interconnection to the Public Telephone Network

The PBX (private branch exchange) functions as an integral part of the public telephone network. PBX's serve essentially the same purpose as the telephone companies' central office switching equipment. They connect extensions of the PBX to each other and, when Telco-supplied, to the multiple address telephone system. The Trans-Canada Telephone System members firmly believe that the PBX function should be owned and maintained by the telephone companies when access to the public telephone network is desired. The justification for this policy is as follows:

a) Control over total system design is maintained.

The co-ordination of innovations in overall system design and operation is made more difficult when the component parts are spread among many owners, each trying to protect his own investment. For example, computerized electronic switching, located in the central offices of the telephone companies, is an efficient and economical method in satisfying the demands of many large businesses. This new

technique can eliminate the PBX as a desirable switching method. If customer ownership of PBX's increases - a result of permissive interconnection policies - then the use of electronic switching for such a purpose may be unnecessarily retarded.

b) Maintenance can be accomplished quickly, since technical specifications are known and one labour group is responsible. The assignment of maintenance responsibility in multiple ownership situations is a difficult, although not unsolvable, problem. There may be overlapping labour union jurisdictions which may hinder the efficient maintenance of customer-owned and telephone company owned equipment located on the customers' premises. Training of employees is simplified when the design characteristics of the overall system are known.

c) The desirability of providing PBX service to all parts of the country on a non-discriminatory and equitable basis is recognized.

Under existing regulations, the telephone companies are required to supply and maintain PBX service at standard rates throughout their service areas. If the telephone companies were requested by their regulatory authorities to interconnect customer-owned PBX's to the telephone network, the market for customer-owned PBX's would expand. As a result, competitive suppliers would concentrate their efforts on the highly populated business centres in order to keep their maintenance and overhead costs at a minimum. If the telephone companies were to continue to be subject to the same regulation as before, then their overall costs would rise, since, in all likelihood, they would be the

only supplier in those areas where maintenance costs were higher. This would give an unfair competitive advantage to other suppliers. If, however, the telephone companies were to compete on the same basis as unregulated suppliers, then PBX prices would undoubtedly fall in lower-cost areas and rise in higher-cost areas. We believe that this practice would not be consistent with the goal of maximizing service development throughout the country and that it would adversely affect users in remote areas.

2. Interconnection Without Network Access

Most telephone companies will interconnect a local one or two-way paging or intercommunication system and a one base-station private mobile radiotelephone system to a PBX for internal use only. Exposure of the overall public telephone network to incompatible systems is thus largely avoided and most of the requirements of the private system owners are satisfied.

The members of the TCTS will generally interconnect two PBX's owned by the same or different customers, as long as there is no access to the public telephone network.

This policy is consistent with the private line offerings of the telephone companies and the previously expressed views on privately-owned transmission systems, including the effects of interconnection on erosion of public telephone network revenues and rate structures.

3. Summary

In considering any change of the interconnection policies described above, the overall integrity of the public telephone network and the long term welfare of all subscribers to the service should be fully considered.

E. TECHNICAL ASPECTS OF INTERCONNECTION OF SYSTEMS AND TERMINAL EQUIPMENT

F. NATIONAL ACADEMY OF SCIENCES REPORT - A SUMMARY

I. Principal Findings

a) Uncontrolled interconnection to the network can cause harm to personnel, network performance and property.

b) Tariff protection criteria are technically based, valid and, if exceeded, can cause harm by interference to other users.

c) Present tariff criteria with telephone company-provided connecting arrangements are acceptable basis of assuring necessary protection.

d) Present criteria with properly authorized and enforced program of standards development, equipment certification and controlled installation and maintenance are also acceptable basis for achieving protection and direct user interconnection.

e) Innovation by carriers need not be impeded by certification program. User innovation opportunity would be increased.

f) Mechanisms are needed to promote exchange of information among carriers, users and suppliers.

II. Harmful Effects of Uncontrolled Interconnection

a) Voltages dangerous to human life

b) Signals of excessive amplitude or improper spectrum

c) Improper line balance

d) Improper control signals

III. Present Carrier Practices

a) Present carrier approach is technically acceptable.

1. Some connecting arrangements may be redundant and duplicate users' equipment and functions. May cause loss in performance and reduction in reliability. However, if well designed, overall reliability and performance not affected.

IV. Establishment of Standards and Enforced Certification of Customer-Provided Equipment and Personnel Also Provide Adequate Protection in Conjunction with Present Criteria

a) Standards should not include standards for user equipment performance except as they would relate to network protection such as personnel safety, signal levels, transmission and network control signalling.

b) Standards, including interface specifications, can be written

c) Customer-provided equipment must be adjustable to recognize the "customization" aspect of each installation.

d) Equipment type certification by Government or independent testing labs. Could include couplers and protective section of larger pieces of equipment.

e) Equipment certification must be accompanied by installation and maintenance by certified technicians.

f) Network protection must be maintained by documented periodic inspection.

g) Federal agency responsible for tariffs must be responsible for certification program.

V. Enforced Certification Program Must Be Taken As A Whole To Be Effective.

a) Standards development or equipment certification without certified testing, installation and maintenance will be ineffective in obtaining necessary network protection.

b) Certification must be by independent effort since self-certification by manufacturers or users will not ensure protection.

VI. There Is No Justification For Exemption Of Whole Classes Of Users From Interconnection Requirements

a) Rights-of-way companies, government, etc., should all be eventually caused to conform to whatever plan is finalized.

VII. Many Misunderstandings Exist And A Mechanism To Promote Exchange Of Information Among Carriers, Users and Suppliers Should Be Developed

VIII. Network Control Signalling Is A Critical Element And High Order Of Reliability Is Necessary To Avoid Loss Of Network Performance And Excessive Costs To Both Carrier And User

a) Touch-tone signalling by customer-provided equipment is less of threat than rotary dial.

IX. Conclusions With Respect To Telephone Company - Furnished Protective Devices

a) Existing connecting arrangements protect against hazardous voltages, excessive signal amplitudes and longitudinal imbalances.

b) Existing protective devices provide minimal protection against faulty network control and signalling.

c) Present connecting arrangements present no concern with respect to increased potentials for service failures.

d) Telephone company-provided connecting arrangements introduce redundancies of functions of user-provided equipment.

e) Telephone company couplers are not "transparent."

f) Some present couplers are dependent on commercial power - significant and undesirable disadvantage.

g) No significant performance degradation is introduced by telephone company couplers.

h) Central office protection cannot provide same degree of protection as customer-site protection.

X. The Certification Program

a) Program should be under final authority of federal regulatory commission having jurisdiction over carriers.

b) Customer should be required to affirm acceptance and understanding of provisions governing the interconnection.

c) Uniform treatment must exist nationwide and not be divided among various regulatory agencies - all certifying organizations should derive powers from federal regulatory agency.

d) A step-by-step program to ensure successful implementation of certification program should be undertaken by F.C.C.

e) Self-certification should not be permitted.

XI. Improved Information Exchange Is Necessary and Organizational Mechanism Should Be Established To:

a) Promote two-way exchange among all parties concerning interconnection problems. Exchange is vital to possible interconnection liberalizations and protection of network integrity.

b) Promote and establish working groups concerned with standards development, certification programs for equipment, licensing programs for installation and maintenance, and data gathering and analysis of technical interfacing problems. Common, authoritative form for reception of data is necessary.

c) Develop recommendations to a federal regulatory agency as to timing of phase-in of certification program, if adopted.

d) Promote good atmosphere concerned with innovation problems in interconnection.

CARRIER: LA COMPAGNIE TELEPHONE UNGAVA
LABRADOR TELEPHONE COMPANY

1. La Compagnie Telephone Ungava and the Labrador Telephone Company are independent companies provincially chartered in Quebec and Newfoundland respectively and which operate the Quebec North Shore and Labrador Railway communication system.

2. The major trunk system, leased from Quebec North Shore and Labrador Railway runs between Sept Iles, Shefferville and Labrador City and is utilized to develop communication services in and around Labrador City area, Shefferville area and along the railway.

3. Under the provisions of the public utility acts interconnection with Bell Canada is made at Labrador City for extended area service and at Sept Iles with Quebec Telephones for long distance services. All interconnection circuits will meet DDD standards.

4. The companies have no serious objection to offering interconnection facilities to private systems provided the requisite, technical, operating and maintenance standards are met by private users. In fact, instances of interconnection between private systems and the switched public telephone networks is made available for the emergency systems operated by the police and fire departments in Labrador City and Schefferville.

5. The companies see no reason why major, private companies

operating a complex communication system should not be allowed to interconnect exchanges provided they can meet the technical and maintenance requirements.

6. However, it is felt that any legislation pertaining to interconnection should have safeguards against interconnection with rudimentary systems operated by non-professionals. Without these safeguards the integrity of the switched public network could be seriously affected.

APPENDIX C.

MANUFACTURERS

MANUFACTURER: AUTOMATIC ELECTRIC (CANADA) LIMITED
Brockville, Ontario

1. The existing policy of Automatic Electric does not favour catering for private customers. A private organization operating other than an extensive communication system cannot normally provide the degree and quality of maintenance required to keep a telephone exchange operational within specified limits. Inadequate maintenance invariably reflects on the equipment manufacturer and causes operational problems. These factors, coupled with the fact the AE is closely associated with the telephone companies, have influenced the company to remain out of the private telephone system market except for isolated systems not connected to the national network.

2. No instances of interconnection between private (hotel systems) and public systems are available from AE's records.

MANUFACTURER: CANADIAN MOTOROLA ELECTRONICS COMPANY
Willowdale, Ontario

1. The company feels that the benefits of a radio paging service to both commercial and non-commercial users, in the form of improved efficiency in day-to-day operations would be further enhanced if the paging terminal facilities of the user could be interconnected with the public switched network.

2. The company attitude toward interconnection of these services with the facilities of the common carriers is based on overall improvement of service and efficiency which present and potential users would obtain from their equipment, as typified in the following:

a) Interconnection of in-plant or in-company radio paging systems with the facilities of the common carriers would increase plant/company efficiency.

b) RCC services, approved by the DOC to offer a paging and dispatch service to the public, cannot interconnect because of policies of the common carriers. These restrictive policies prevent the RCC from offering a better service than would otherwise be the case and force potential users to obtain service from the common carriers.

c) Users of two way radio systems would benefit if phone patching facilities providing interconnection with the public switched network were permitted.

d) In-house data services could be expanded and improved if int interconnection, based on known standards of performance between the interconnecting systems, and the provision of adequate maintenance on the part of the public switched network.

MANUFACTURER: L. M. ERICSSON LIMITED, Montreal, P.Q.

1. Ericsson's largest customers are common carriers such as Manitoba Telephone System, Maritime Tel. & Tel., New Brunswick Tel. Co., and Bell Canada. Thus the company has a preference for not drastically changing the situation in Canada.

2. Basically, Ericsson prefers to sell quality equipment on the basis of its good reputation. In fact the present policy of the Company discourages selling systems if there is any suspicion that equipment supplied would not be maintained properly.

3. The other aspect of Ericsson business is communication systems and other private systems that are not normally interconnected.

4. Ericsson's position can be summarized as:

(a) Common carriers provide the bulk of the company business.

(b) The company produces high quality, highly reliable systems and equipment and therefore prefers closer ties with the common carrier.

(c) If unlimited forced interconnection became a policy, lower quality and lower priced competitors would enter the field in which case Ericsson would prefer to continue dealing with the common carriers wherever possible, in order to protect their reputation. Alternatively, Ericsson

would consider forming their own sales organization for areas where they are unable to supply equipment directly to the common carriers.

5. Even though a great deal of company income is from sales to common carriers it is by no means a captive supplier and has other markets for its products.

6. Regarding maintenance and quality control the company position is as follows:

(a) A properly installed system does not require routine maintenance for perhaps the first two years. The main problem is therefore proper installation.

(b) Installation technicians must know the equipment and the system if proper function is to be expected.

(c) Maintenance must be carried out by similarly highly skilled people.

(d) Regular maintenance is not needed on Ericsson installations It is generally sufficient to troubleshoot faults as they arise.

7. Ericsson is concerned about the future and is extremely interested in the recommendations of the Telecommission.

MANUFACTURER: NORTHERN ELECTRIC COMPANY LIMITED,
Ottawa, Ontario

1. Northern Electric (NE), like other major manufacturers of telephone equipment in Canada, prefers to deal only with the telephone companies for the sale and installation of its telephone exchanges.

2. At present the company is not fully geared to enter the private telephone system market. However, if the situation arises and if it chooses to, NE does not foresee any major problem in orienting its activities to meet private user requirements.

3. In NE opinion, any legislation allowing uncontrolled interconnection of private systems to the public telephone network would adversely affect the telephone system integrity mainly through substandard installation and poor maintenance.

4. NE, as a major supplier of telecommunication equipment in Canada has development programs to meet the communication needs of the future. It considers that the prevalence of uncontrolled interconnection may alter telephone companies' thinking and jeopardise major programs for the modernisation of their plant.

TELECOMMISSION

Study 8(b)(ii)

Interconnection Between TCTS and CN/CP Telecommunications

The Department of Communications

TELECOMMISSION Study 8(b)(ii)

INTERCONNECTION BETWEEN TCTS

and

CN/CP TELECOMMUNICATIONS

TWX TELEX

VOICE DATA

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Ottawa, 1971

This Report was prepared for the Department of Communications by a project team made up of representatives from various organizations and does not necessarily represent the views of the Department or of the federal Government, and no commitment for future action should be inferred from the recommendations of the participants.

This Report is to be considered as a background working paper and no effort has been made to edit it for uniformity of terminology with other studies.

PURPOSE

The purpose of this study is to examine carrier-to-carrier interconnections, including the TWX and Telex systems, to determine whether formulation of Government policy or legislation is required.

TERMS OF REFERENCE

The proposed terms of reference are:

1. What will happen if the Government takes no active role in the development of the system?

2. What would be the evolution of the systems which would best serve the public interest?

PROJECT TEAM

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PART I INTRODUCTION

The study has been conducted on a broad base. An effort was made to determine the significance of the TWX-Telex systems in Canadian telecommunications technology. The relationships between these services and the developing Data transmission services were studied on the premise that TWX-Telex might be considered as low speed data systems with a future that was predictable according to how data systems might develop. This premise was found to be essential to an overview of the subject.

The question of interconnection between the two systems is reviewed, both from technical and service standpoints. The idea that these systems are a special case of the question of interconnections between the TCTS and the CN/CP Tel organizations is examined. It will be seen that this assumption does not materially contribute to the solution of the principal questions on interconnection. In fact the TWX-Telex question will be shown to be essentially a problem of another genre.

Considerable research and study were directed to the situation in the U.S., where acquisition of TWX by Western Union which operates Telex, is under way. Events in Canada often follow the U.S. leads. It was necessary to determine the basic reasons for the proposed merger in the U.S. and to draw accurate comparisons between the Canadian and U.S. situations. It will be seen that if Canada were to follow the U.S. lead it would be for somewhat different reasons. A definite impact of the U.S. action on Canada can be

foreseen and it must be recognized as a factor in Canadian planning.

Brief studies were also made of developments in policy, planning and hardware in France, Great Britain and Germany. It was found that these nations, and West Germany in particular, appear to be several years ahead of Canada in some respects and in fact Governments of the Continental group and the U.S. have already assumed positions as a result of studies conducted since approximately 1965, and for which there appear to have been no parallels in Canada. A chart has been prepared forecasting the development of communications technology on a world basis using data from U.S. sources and the study of the European programs. Timing of corresponding developments in Canada will depend largely upon the expedition with which the necessary policy decisions can be made.

Since all recommendations can be expected to involve relations between DOC and the two principals, namely CN/CP and TCTS, it was considered necessary to briefly comment on the nature of these latter two organizations and to state certain assumptions with regard to their continuing status.

The subject of interconnection of all systems is dealt with separately in detail by papers submitted by the principals. An analytical discussion on these two papers has been added. Lastly, the concept of integration rather than interconnection (except for voice services) is discussed.

PART II DESCRIPTIONS OF TWX-TELEX SYSTEMS

2.1 Definition

The terms TWX and Telex are derived from 'teletype exchange'. Telex is the older service and is world wide. TWX originated with A.T.&T. in the U.S.

2.2 Terminal Devices

These devices perform the dual functions of message encoding and decoding as well as of functioning as signalling devices. In addition to a printing mechanism there is a signalling dial. The electromechanical printers in use have not changed radically over the years. Their characteristic disadvantages are the noise they generate and low speed. Various efforts have been made to improve them. The printers are associated with keyboards, typically 3 row for the low speed Baudot code Telex service and 4 row for 8 bit ASCII code for Data-Telex and all TWX services. The principal advantage recently has been in the introduction of the electronic keyboard. The keys in this unit are not mechanically linked to the typing mechanism as in the older models. Instead, they generate electrical signals which operate the printing mechanism and also the line output circuits. An example of these new keyboards is seen in the accompanying illustrations of new terminal equipment, ref Figs. 1*, 2.

Besides the basic manual input facilities noted, there are attachments available for automatic send and receive operation. For these purposes terminals are fitted with paper tape punches and/or readers. When TWX stations are operating into computers automatic

* The Siemens Model 150 is not in service in Canada at this time.

FIG-1

SIEMENS Teleprinter MODEL 150

5 level unit with electronic keyboard, paper tape and dial units. Used for Telex.

FIG-2

TELETYPE CORP., Teletype Model 33 ASR

8 level code, with paper tape
and dial as used for TWX

send and receive terminals are important to system utilization.

Teletype terminals employed in the two systems have few distinguishing external characteristics. An important difference is that TWX terminals require a modem to convert the keyboard output to the tone signals which are the transmission media. The unit manufactured by Northern Electric is illustrated in Fig. 3. The modem approximately doubles the cost of the basic manual input TWX terminal over the similar Telex unit, however this is offset in the Telex system by the cost of multiplexing equipment which is not required by TWX.*

In their Telex applications Canadian National and Canadian Pacific Telecommunications employ a variety of teleprinter and terminal equipment. On the 50 baud general Telex network the most commonly used are Teletype Corporation's Model 32, Model 28 and Lorenz Model 15 machines. On the Data-Telex networks where the speed (up to approximately 180 bauds) and the code are nonrestrictive there is a wide choice of terminal equipment such as the IBM 1050 machine and Teletype Corporation's Model 33 or 35 dependent on the customer's requirement. The new Siemens Model 200 is illustrated in Fig. 4.**

Principal suppliers of equipment to the Canadian systems have been Siemens (Germany) and the Teletype Corporation (U.S.). Until recently tooling and other costs compared to the market made it uneconomical to attempt production in Canada. Factory level repair and overhaul facilities are maintained by CN/CP for their equipment.

* Telex retains an advantage as the multiplexing is not required at each terminal.

** Not in service in Canada at this time.

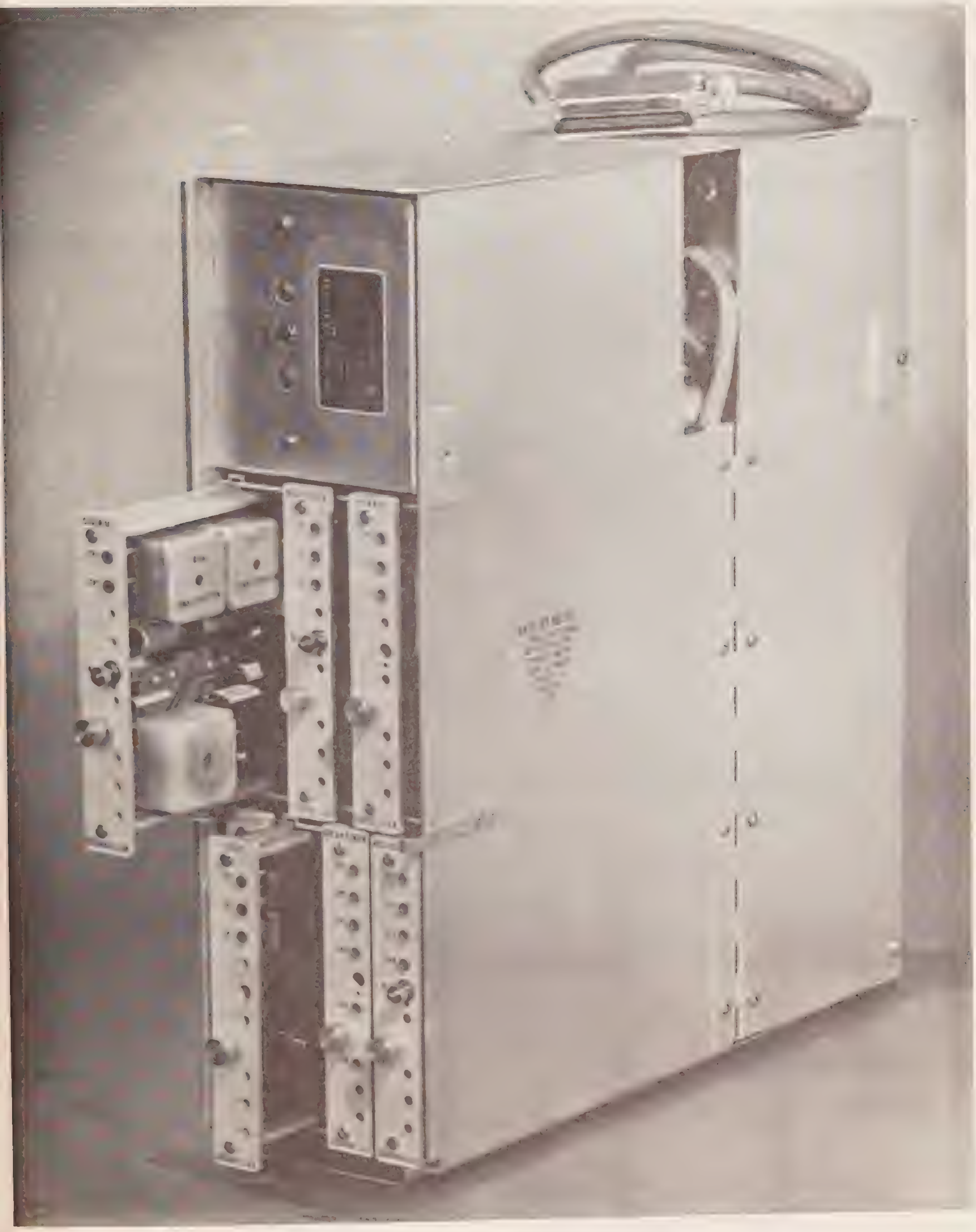


FIG-3

NORTHERN ELECTRIC Data Set 101C,

Modem for TWX service

FIG-4

SIEMENS Model 200 Teleprinter

Operates up to 200 Bauds, 8 level
code, with paper tape and dial.
Designed for DATA-TELEX, etc.

that the Teletype Corporation is considering licensing a Canadian company to supply maintenance, and for repair and overhaul facilities.

2.2.1 Future Developments - Computers within the system as in the proposed TELENET service are revitalizing the systems to provide better, faster service and fuller utilization, however no corresponding changes have been made in terminals which limit the speed of TWX and Telex services. Both the manual keyboard, and the paper tape feed currently used for automatic send and receive are low speed data devices. Siemens and many other suppliers offer a versatile electronic display system, Model 1850 Data Display Terminal, which is illustrated in Fig. 5. This unit operates at 1200-2400 b/sec. It would be technically quite feasible for a subscriber to ask for a display terminal such as this, which is noiseless and could be conveniently located in a private office with a printer remotely connected in a loop. It is a question of market demand. Introduction of such devices into the business office as a computer service will probably result in a demand for its use in regular message service. Other developments include modems which incorporate delay line memories to serve as buffer storage to assist the system designer in accommodating busy signal, or priority message situations.

It is generally considered that as with the telephone service which will be complemented but not displaced by videophone service, there will continue to be a demand for low speed teletype services. As business usage grows and the networks become more complicated the great pressure will be to improve system utilization by

FIG-5

SIEMENS Model 1850

Electronic DATA Display

Has associated 5 row keyboard central unit, 64 characters. Operates on ASCII at 1200 or 2400 b/s. Data Teleprinter 200 can be connected to the control unit to furnish hard copy.

greater technical efficiency and by off-peak load services. System capacity will increase for storing messages of a low priority nature so that they can be transmitted at night or during off-peak periods. Such storage of course is a facility associated with every computer central processor. Maximum efficiency in use of such storage requires high transmission speeds. We can expect the TWX-Telex services to eventually employ a range of transmission speeds. Truly high-speed data transfer on a general random access basis probably will require entirely new plant, designed for digital transmission, not just modified voice frequency services.

2.3 Telex System Description

2.3.1 General - The system consists basically of automatic switching equipment, trunk circuits interconnecting these various exchanges, subscribers' teleprinter equipment with the exchanges.

The Canadian Telex system is a public automatic exchange network which is composed of a three level hierarchy of exchanges:

1. Junction Exchanges
2. District Exchanges
3. Sub-District Exchanges and Concentrators.

International Telex calls to the United States and Mexico are made via Western Union facilities and overseas calls via Canadian Overseas Telecommunications Corporation facilities. At present, international gateway exchanges to the United States are located at:

Vancouver which is connected to Western Union San Francisco

Winnipeg which is connected to Western Union Chicago.

Toronto which is connected to Western Union Chicago.

Montreal which is connected to Western Union New York.

Overseas connections are made via COTC at Vancouver (to be phased out August 13, 1971) and Montreal.

The signals on the general Telex network are at a rate of 50 bauds, are a synchronous (start-stop) and use the 5 unit code (7.42 elements per character including a stop pulse of 1.42). CCITT keyboard and alphabet (international code No. 2) are employed throughout the system. The subscribers' station is equipped with a control unit, incorporating a dial plate, a page printer and, if requested, a tape perforator and tape transmitter.

For customers requiring higher speeds, up to approximately 180 bauds, a network, designated Data-Telex, is provided using appropriate trunks. Basically, it is very similar to the 50-baud general telex network so far as the exchange equipment and network layout are concerned but any code and any speed up to 180 bauds may be used depending on the customer's requirement. Up to nine Telex circuits can be derived from one standard voice channel. Customers of the Data-Telex network are not provided with a directory, and cannot generally communicate with standard Telex network customers. This is principally due to incompatible terminals. However, arrangements can be made upon demand to effect intercommunications.

2.3.2 Layout of Network - Junction exchanges are all directly interconnected with one another (Fig.1)* to provide direct access between them, (and are located with a geographical and economic point of view). Their main function is to provide a connection between district networks either in their own areas or the areas of other junction exchanges.

All District exchanges are connected radially to parent junction exchanges (Fig.1),* (within the geographical area of that junction exchange). District exchanges are not directly interconnected, but are connected only to junction exchanges with calls between District exchanges being established through junction exchanges. District exchanges serve as the connecting link to the subscribers.

Sub-exchanges may be considered as satellites of District exchanges. They are remotely located from the District offices and serve as the connecting link to the subscribers in a particular area. All connections to the subscriber on sub-exchanges are made through District exchanges.

2.3.3 Numbering Scheme - An open numbering scheme is employed. Each junction office (Area Office) is assigned a number: i.e. Montreal 01 and 05; Toronto 02 and 06; Winnipeg 03 and 07 and Vancouver 04. The digit 0 indicates that the call must be switched through one of the junction offices (long distance). The area digit that follows indicate which junction office (or area) is required.

* Appendix A

Identification of District Office to which a subscriber is assigned is by the third digit:

Example: 037

0 - indicates long distance

3 - indicates Winnipeg Junction (Area) Office

7 - indicates the Edmonton District Office.

Sub-exchange offices are designated by the fourth digit. It should be noted that the fourth digit is not isolated to sub-exchange only but could represent as well for example a Local Subscriber group in the District Office. The last two digits provide the subscribers number.

Example: (1) 037 2185

037 - Edmonton District Exchange

2 - 1000 group - Edmonton

1 - 100 group - Edmonton

85 - subscriber's private number.

(2) 037-5185

037 - Edmonton District Exchange

5 - Peace River (Sub-Exchange)

1 - 100 Group Peace River

85 - Subscriber's private number.

For Telex calls to the United States, preliminary digits "00" (zero-zero) followed by the subscriber's complete number as listed in the Western Union directory will provide access to

the Western Union subscribers. Telex service to countries other than the United States is supplied by the International carrier switchboard facilities at Montreal (COTC) and Vancouver (COTC). Access to the "Overseas operator" is made by dialling the gateway junction office at Montreal or Vancouver followed by digits "00". (Example 0100, 0400). After establishing connection to the "overseas operator" the destination code and overseas subscribers number are typed on the keyboard. Complete instructions for international calls are contained in the Canadian Telex Directory.

2.3.4 Technical Characteristics - All exchange equipment in the Canadian Telex network has been purchased from Siemens Halske* in Germany. In recent years Canadian National and Canadian Pacific Telecommunications have purchased from Siemens a new and more sophisticated type of Telex exchange system known as TWK. These new exchanges are designed to be compatible with the electro-mechanical step-by-step TW39 systems initially provided by Siemens Halske. For the purpose of this presentation, a brief description of both systems will be provided.

The TW39 Automatic Teleprinter Exchange system is an automatic switching system operating on the dial switch selection principles, i.e. the subscribers establish the desired connection themselves by simply operating a dial switch provided on the subscriber machine.

* Now "Siemens" which have a Canadian facility.

The various selection stages of the system are provided with rotary stepping switches and two-motion stepping switches. The rotary switches are used in the preselector stage facing the subscriber while the 100 outlet two-motion switches are in the group and final selector stages. The group and final selectors are directly controlled by the selection information transmitted by the subscribers in the form of dial pulses. The number of selection stages is dependent on the size and type of exchange (i.e. junction, district or sub-exchange). (Fig.2,3,4)*

The TWK system uses COMMON CONTROL facilities and Relay Matrices to perform its switching functions. Its notable features are not only its compact constructional design and the use of ESK relays in its switching matrices but also its programmed functions which closely resemble those of a computer. The basic model of the TWK teleprinter exchange performs the same functions as the step by step TW39 systems. Connections are established by way of a three stage link network operating with ESK relays which are used in place of selector switches.

Dial pulses are stored and the dialed information is decoded and read into the common control for corresponding control instructions. The subscriber stations are connected to line terminating sets within the Exchange. Each line terminating set may be circuited for mode-of-operation, subscriber category, and other

* Appendix A

criteria by proper programming. The TWK exchanges in Canada are designated as TWK-2, and TWK-8. The principles of operation of the different models of TWK exchanges are basically the same but differ in capacity and special features which will be considered unimportant for this presentation. (Fig. 5)

The same principle has been further developed in such a way that it is suitable for tandem exchanges where trunk lines only are interconnected. These exchanges are designated as TWK-D exchanges and are being installed in the junction offices across the system. Although used as a junction exchange at present, it should be noted that the TWK-D can be employed as a District exchange. Subscribers cannot be connected directly to a TWK-D exchange.

General requirements of the system and component exchanges include:

System should cater to the subscribers' offered load with an overall grade of service of 1 in 100. (The case of called-subscriber-busy is excluded). Lost call rate through individual switching stages is 1 in 1000.

Automatic Time Zone metering is performed at originating exchanges to enable charging a subscribers in accordance with the distance and duration of a call. "Free of Charge" calls, e.g. to Information positions, telegram message positions, International switchboards, etc., are provided.

Selector stages respond to dial-pulse trains conforming to CCITT recommendations (i.e. 40/60 milliseconds make-break).

2.3.5 Signal Facilities - Siemens Telex Exchange equipment provides the following facilities:

(a) A revertive pulse is transmitted from a distant exchange upon seizure of a trunk to that exchange.

(b) A free line signal of at least 800 MS marking is transmitted from the called exchange to signify to the calling exchange that the called subscriber's machine has started and so that charge timing of the call can commence.

(c) A cyclic busy signal of 200 MS marking followed immediately by 1.2 second spacing is transmitted under the following circumstances:

- When the called subscriber is busy.
- When all available intra-exchange trunks between switching stages are busy.

- If a subscriber fails to dial or to complete dialling.
- When a cancelled number is dialled.

(d) The TW39 and TWK-D exchange uses CCITT type "B" signalling and can be interconnected with exchanges of any type employing the same signalling scheme.

2.3.6 Time Zone Metering - The Time Zone Meter equipment as part of the exchange equipment is required for automatically charging the subscriber for his call. This equipment has been designed to accept and evaluate the first four digits as it monitors the line.

Fourteen pulse rates are currently employed. An appropriate pulse would be applied to the subscribers meter but only when the called party has been reached successfully.

The Time Zone Meter is seized and held by the originating subscriber for the duration of the call.

Modifications to the charge rates are conveniently carried out by the use of strapping on the TW39 equipment and by programming on the TWK equipment.

In TW39 exchanges the charge meters may be associated with the line terminating sets, but it is preferable to arrange all meters centrally located on a separate rack. With TWK-2/8 exchanges this is the standard arrangement.

2.3.7 Pulse Generator - The pulse generator, part of the exchange equipment, is required to apply selected rates of metering pulses to the subscribers charge meter. Aside from generating metering pulses, however, the pulse generator provides pulses used in alarm delay circuits. It is possible, for example, that the 1 ppm rate could be used to control alarm relays associated with equipment racks.

Generation of metering pulses may be by electro-mechanical or electronic means. These pulse rates are: 1, 2, 3, 4, 5, 6, 7.5, 8, 10, 12, 15, 18, 22, 24, 30, 36, 40, 45, 60, 72, 90, 120, 180, 360 pulses per minute. They are of square waveform and a length of 65-90 milliseconds negative 60 volts. The pulse output must be grounded in the period between each pulse.

This output is also monitored so that a disconnection, permanent grounding or short circuit affecting the output of any pulse lead will be indicated immediately in the form of an urgent alarm. This alarm also indicates ineffectiveness of a pulse caused by loss of power or severe distortion, for example. (Not part of TWK-2/8 exchanges.)

2.3.8 Subscriber Equipment - All Telex subscriber equipment is connected to a Telex exchange circuit by way of a remote control unit. The remote control unit varies considerably in design

depending on manufacturer and teleprinter employed. Certain teleprinters have inbuilt solid state control units while others require the addition of these units. In spite of the differences of designs, all remote control units are required to perform certain basic functions.

The remote control unit will automatically connect the teleprinter upon the arrival of a call without the need of an attendant. It contains all the control elements and electrical switching means required for setting up or clearing a connection. These include the dial switch, a calling and clearing key, a visual indicator which, after the calling key has been depressed, indicates when dialling can begin and finally an indicator light which remains illuminated as long as the motor of the teleprinter is running and the teleprinter is engaged. In addition to the above control elements, some remote control units of special design permit local loop operation. This feature allows the teleprinter to be used for typing practice or preparing perforated tape when the teleprinter is equipped with a reperforator unit. When the teleprinter is in this mode its ability to receive calls is not impaired as all incoming calls take priority over any local operations, thus a buzzer will sound for approximately 3 seconds after which the teleprinter will be switched automatically from local to exchange operation.

The Telex subscriber is normally connected to the Telex exchange via a 2-wire circuit. This circuit operates on either a 40 or 60 milliampere closed current and connects the subscriber on a half duplex basis (two-wire local). In the event the connecting circuit between the subscriber and the exchange is too long and either the 40 or 60 milliampere loop current cannot be sustained, the subscriber must be connected to exchange as a long distance subscriber.

In the long distance configuration the mode of the teleprinter itself remains the same as with a local subscriber except that a device known as either a polar adapter or d.c. converter is introduced at the point where the exchange loop meets the teleprinter. With this device the operating current is usually reduced to 20 milliamperes and the operation is in the polar mode which is more suitable for transmission over long distances. For moderately long distances polar transmission can take place over physical transmission facilities. However, in cases where a subscriber is located a great distance from a Telex exchange a voice frequency telegraph channel may be required as the medium. Each Telex subscriber connection is carefully evaluated and the correct circuit configuration is designed and implemented for optimum transmission quality.

2.3.9 Trunk Facilities - Telex exchanges are interconnected by voice frequency carrier telegraph channels. In general the

majority of VFCT systems on the Canadian Telex network employ the frequency shift modulation technique which is considered superior in performance to the amplitude-modulation systems. The amplitude-modulation VFCT systems are still existent in the network but are gradually being replaced.

On the 50 baud general Telex network, VFCT channels are spaced at 170 Hz. Depending on the bandwidth of the available voice path, it is possible to provide up to 18 VFCT channels. For higher speeds up to 180 baud, VFCT channels spaced at 240 Hz are provided. Fig. 7* illustrates the standard frequency spectrum of these channels.

2.4 Tel-Tex Service

In this service the customer may get a message through to a non-subscriber by dialing the nearest telegraph company terminal in the Telex network using a special code. An operator at the terminal takes the message and gives it the same service as is offered for telegrams i.e. telephone call to destination followed by mail service or on occasion direct delivery. The normal Telex rate plus a flat fee of $1.00 is charged. The service is available in approximately 110 cities plus 1,000 small communities. This system considerably extends the coverage of the Telex system although it does so by adding a time-delay.

2.5 TELENET Service

TELENET is a pay-as-you-use CP/CN general service

* Appendix A

offering providing a computer-oriented store-and-forward message switching service for the medium size communications user. The system is controlled by Philips DS-714 computers located in Montreal and Toronto. Customer service is planned early in the first quarter of 1971.

Each subscriber network is private. The exchange of messages, between networks via the computer, is prohibited by computer program, at least in the initial offering.

Subscriber network stations are categorized into three classes of service dependent upon volume of traffic or the grade of service required.

Class A is a heavy volume station provided with a dedicated circuit and a dedicated computer port. A Class A circuit may have more than one station, provided the stations belong to the same network.

Class B is a medium volume station provided with computer access circuits via the Telex or the Data-Telex networks. Computer ports are shared. The station is equipped for Telex operation and has access to and from the regular subscribers of Telex or Data-Telex.

Class C is a light volume station similar to Class B.

Stations are provided with teleprinter equipment operating initially up to 100 wpm in either 5 or 8 level codes, as applicable. Individual network circuits may be any code or speed. Speed conversion and code translation is provided by the computer.

A billing program in the computer records character usage for those network charges based on usage rather than fixed charges.

Group address and book message capability is provided. Each message sent by a station is individually accepted or rejected by a computer-generated notice. Message retrieval is possible up to three months.

Subsequent phases will offer high-speed data handling capability, interface with customer-owned computer, and message refile.

2.6 Telex Economics

2.6.1 Investment and Revenue - Capital investment figures for the Telex system are not readily available. CPR which capitalize Telex switching, trunking and subscriber station equipment in separate accounts, show new capital expenditure up to the end of 1969 to be $29,500,000 and supplement this with the statement that this does not include the

capital value of microwave channels nor the value of existing plant utilized in Telex service. With the CN, the situation is complicated by the admixture of telegraph trunk costs. Their investment in Telex, Broadband, and subscribers equipment totals $51,000,000 approximately. This is exclusive of microwave or other long line facilities. The total CN/CP capital investment in telecommunications plant currently is $430,000,000 approximately, of which the major share rests with CN Telecommunications.

As a means of comparing the scale of the investment with other countries we note the following.

CN/CP Tel, Telex terminals in Canada -	20,000 subscribers *
USA	32,000 "
West Germany	70,000 "

Gross joint revenues from Telex for the past four years were:

Year	Amount $	% Increase
1966	17,546,000	
1967	20,664,000	17.5
1968	25,178,000	22.0
1969	29,804,000	19.0

2.6.2 Subscriber statistics - Coverage of the Telex network is summarized in the following tables. These refer to 1970 levels. The first table is of 50 baud domestic Telex terminals. The second is of the Data-Telex system. The number of terminals is said to be increasing at the rate of 15% annually.

* capacity 29000

Coverage - Subscriber Lines

50 BAUD NETWORK

Province & City	Qty.
NEWFOUNDLAND	
St. John's	410
Cornerbrook	140
Gander	50
Grand Falls	100
Goose Bay, Lab.	110
NOVA SCOTIA	
Halifax	550
Kentville	90
Yarmouth	50
Amherst	20
Truro	50
Port Hawkesbury	20
New Glasgow	100
PRINCE EDWARD ISLAND	
Charlottetown	100
Summerside	50
NEW BRUNSWICK	
Saint John	230
Fredericton	150
Woodstock	50
Moncton	310
Edmunston	20
Campbellton	100
Bathurst	50
QUEBEC	
Montreal	3520
Granby	20
Drummondville	20
Thetford Mines	20
Trois Rivieres	80
Sherbrooke	80
Ste. Thérèse	20
Quebec	460
Noranda	50
Val d'Or	50
Senneterre	100
Roberval	20
Chicoutimi	120
Riviere du Loup	20

Province & City	Qty.
QUEBEC (Continued)	
Pointe Claire	200
St. Jean	50
St. Georges de Beauce	50
ONTARIO	
Ottawa	740
Pembroke	40
Renfrew	20
Peterboro	60
Cornwall	50
Toronto	3840
Cooksville	280
Hamilton	380
Brantford	100
St. Catherine's	130
Niagara Falls	20
Kingston	80
Bellevile	80
Brockville	50
Kitchener	230
Guelph	100
Galt	90
Stratford	40
London	310
Woodstock	40
Sarnia	80
Windsor	230
Chatham	50
St. Thomas	60
Leamington	20
Sudbury	240
North Bay	230
Sault Ste. Marie	100
Brampton	150
Owen Sound	60
Barrie	80
Oshawa	60
Weston	400
Scarboro	400
Oakville	60
Kenora	40
Dryden	40
Fort Frances	20
Thunder Bay	310
Atikokan	20

(Cont'd)

TABLE 1

Province & City	Qty.
MANITOBA	
Winnipeg	1400
Brandon	100
Dauphin	50
The Pas	100
Gillam	20
Churchill	50
Thompson	70
Flin Flon	50
SASKATCHEWAN	
Regina	440
Saskatoon	440
North Battleford	60
Prince Albert	100
Yorkton	50
Estevan	50
Weyburn	50
Moose Jaw	80
Swift Current	90
ALBERTA	
Calgary	1300
Red Deer	60
Medicine Hat	100
Lethbridge	160
Drumheller	20
Edmonton	1400
Lloydminster	20
Jasper	50
High Level	20
Grande Prairie	100
BRITISH COLUMBIA	
Vancouver	2600
Chilliwack	40
Abbotsford	40
New Westminster	150
Powell River	20
Langley Bank	40

Province & City	Qty.
BRITISH COLUMBIA (Cont'd)	
Kamloops	230
Revelstoke	50
Vernon	110
Kelowna	110
Penticton	110
Nelson	100
Cranbrook	120
Trail	60
Nanaimo	100
Campbell River	50
Courtenay	50
Port Alberni	50
Victoria	270
Duncan	40
Prince George	360
Smithers	50
Terrace	70
Prince Rupert	80
Burns Lake	20
Kitimat	50
Quesnel	40
Williams Lake	40
Dawson Creek	100
Fort St. John	100
Fort Nelson	40
NORTHWEST TERRITORIES	
Hay River	100
Yellowknife	50
Inuvik	50
YUKON TERRITORY	
Whitehorse	150
Watson Lake	50
TOTAL	29230

Coverage - Subscriber Lines

DATA TELEX NETWORK

Province & City	Qty.	Province & City	Qty.
NEWFOUNDLAND		MANITOBA	
St. John's	20	Winnipeg	100
NOVA SCOTIA		SASKATCHEWAN	
Halifax	50	Saskatoon	40
		Regina	40
NEW BRUNSWICK		ALBERTA	
Moncton	60	Edmonton	60
		Calgary	100
		Grande Prairie	20
QUEBEC		BRITISH COLUMBIA	
Montreal	160	Vancouver	150
Quebec	40	Nelson	20
Senneterre	20	Kamloops	20
ONTARIO		Nanaimo	40
Toronto	200	Prince George	20
Kingston	20	Victoria	40
Hamilton	40		
London	40		
Kitchener	40		
Sudbury	20		
Thunder Bay	20		
Ottawa	40		
		TOTAL	1420

TABLE 2

2.7 TWX - Economics of the Present System

2.7.1 Introduction - The following is extracted from a TCTS letter of July 7, 1970.

2.7.2 Equipment Inventory - Year End 1969

- TWX machines - 3840 (including on shelf backup equipment).
- Each machine has an associated data set.
- There are 14 positions of the 6A Dial Assistance Board located in Montreal.
- Inventories on facilities, switching, etc. are not specifically accounted on a basis which permits identification to individual service offerings. These facilities are normally shared with many other service offerings of the Telephone Companies.

2.7.3 Planned Plant Expansion

- Growth in terminal equipment is anticipated to be in the 10% range for the next two years.
- TWX usage and its growth trends are incorporated in total usage and growth forecasts and cannot be identified without conducting extensive and detailed studies.

2.7.4 Capital Investment

The existing investment which can be clearly identifiable to providing TWX service is approximately $17.0 million. This figure includes machines, data sets, junctors, trunk relay equipment, dial assistance boards, speed and code converters and test equipment. No attempt has been made to allocate facilities used on a shared

basis with other Telephone Company services such as circuits or switching facilities.

It should be noted that nearly 700 TWX stations are used by the Trans Canada Telephone Companies in conducting their own business and for intra-industry intercommunications. Thus a significant portion of investment is dedicated in furnishing communications to the industry for which no revenue is allocated in these statistics.

Capital investment forecasts are generally restricted to machine and data set requirements which are anticipated at 10% for 1970-71.

Revenues - Total TWX revenues within Trans-Canada were $4.3 million for the year 1969. Forecasts indicate a year on year increase of 10% per year for the 1970-71 forecast period.

2.7.5 General - Operating costs associated with TWX are not accounted independently and as such are unavailable. Most Telephone Company people (sales, business office, engineering, maintenance, installation, etc.) are multifunctional and they, as well as the costs incurred in supporting them, constitute a minor expense in the cost of the total business. Special and lengthy studies would have to be undertaken to approximate specific costs in this area.

2.8 Government Usage of Telex

The Government is a very large user of teletype services. Annual expenditures for teletype and telegram messages approximate $1.7M (Million) of which $1.1M is for Toll charges. The

system serves all provinces and a total of 254 localities. Complete details of the service are available in the Government Telecommunications Agency. A statistical study of usage by twenty-seven Federal Government Departments and Agencies was conducted in April 1968 by that agency and informative extracts from this study are reproduced herein.

2.8.1 Considerations - The Government employs no TWX service. Reasons advanced for this situation are as follows. Historically the Telex service started first and when TWX came along it offered no advantages conducive to a changeover. Secondly the Telex service is more economical for the purposes of the Government. This is because the Government also makes use of extensive telegraphic services. These are combined with Telex in the Tel-Tex system to provide essentially a cheaper telegraphic service. In addition, of the 15% approx of Telex messages which go outside the Government system, the Tel-Tex system has a 4 to 1 chance of reaching a receiver more cheaply than TWX because of the greater number of Telex terminals.

The extent and distribution of the government services are given by Table 3. Typically there are 3 to 4 terminals per community. The 1968 report notes a total of 111,853 messages in the one month period with an average message length of thirty words. Table 4 gives distribution of the service by Departments and Agencies.

The Government is by all standards a very big user of teletype service, and it has selected Telex as the Message-Record service most suited to its needs.

Government of Canada Telex Services

As of March 31, 1970, 725 Telex machines were in service for 44 Departments and agencies in 254 communities in Canada.

Distribution by Provinces:

	Units	Communities
British Columbia	119	46
Alberta	57	20
Saskatchewan	46	18
Manitoba	54	18
Ontario	193	45
Quebec	127	61
New Brunswick	22	11
Prince Edward Island	4	2
Nova Scotia	46	13
Newfoundland	23	10
Yukon	9	3
Northwest Territories	25	7
	725	254

TABLE 3

Telex Distribution by Departments/Agencies

	Units
Manpower & Immigration	193
Transport	110
R.C.M.P.	95
U.I.C.	59
Indian Affairs & Northern Development	40
National Defence	25
Post Office	18
Public Works	18
Agriculture	16
External Affairs	13
Industry Trade & Commerce	12
Supply & Services	12
National Harbours Board	11
Solicitor General	10
Government of Northwest Territories	9
National Research Council	8
Northern Canada Power Commission	8
Energy Mines & Resources	8
Regional Economic Expansion	8
St. Lawrence Seaway Authority	7
Fisheries & Forestry	6
National Health & Welfare	5
National Revenue	4
National Film Board	3
Secretary of State	3
National Library	2
Canadian International Development Agency	2
Dominion Bureau of Statistics	2
Labour	2
Canadian Transport Commission	2
Veterans Affairs	1
Public Service Commission	1
Defence Construction Limited	1
Crown Assets Disposal Corp.	1
Communications	1
Canada Council	1
National Parole Board	1
Privy Council Office	1
Export Credits Insurance Corp.	1
Finance	1
Governor General	1
Canadian Livestock Feed Board	1
Canadian Radio - Television Commission	1
Defence Research Board	1
	725

TABLE 4

PART III INTERCONNECTING TELEX WITH TWX

3.1 Introduction

The foregoing has provided a brief description of the operation and technical characteristics of the Canadian TWX and Telex networks. The following will attempt to outline in general the problem areas in interconnecting the two systems.

3.2 Comment from CN/CP Tel

To appreciate fully the differences in the two systems, it is necessary to first describe briefly the basic concept of the TWX system. Each subscriber is connected to an automatic telephone central office and is able to dial and establish connections over the DDD network. Adaption of the teletype or other digital equipment to the long distance network for transmission over a voice communication network in the frequency range of 300 to 3000 cps is accomplished by the use of the Data Set at the subscriber's location. Since calls are to be initiated and established over d-c controlled, local subscriber loops, the subset provided has a standard dial and a "receive only" handset, as well as a ringer and pushbutton for controlling the Data Set. The central-office switching equipment establishes connections and provides audible supervisory tones in the same way as when handling telephone traffic.

A typical Data Set utilizes the frequency modulation mode and provides two frequency-divided transmission channels to allow transmission in both directions (1170 $\pm$ 100 cps, 2125 $\pm$ 100 cps). The two extreme frequencies in each channel are assigned to the two

digital states (mark and space). On receipt of the dc pulses (binary, serially coded bits) the tone frequencies shift 200 cps between 1270 and 1070 in one channel, and between 2225 and 2025 cps in the other channel. The above tones are also used for supervisory function (i.e. answer supervision, circuit assurance), and the frequency 2225 cps is used for disabling the echo suppressor on the telephone network prior to data transmission. The 200 cps frequency shift provides a theoretical maximum information rate of 200 baud. The Data Set is also equipped with data interface leads to the teletype or other digital equipment for control purposes.

In both Telex and TWX systems the subscriber is able to dial other subscribers in his respective network. The significant difference between the two systems is the method by which the transmission path is established. In the TWX system, DDD telephone is used, making it necessary for the signals to be in an A.C. analog form. In Telex, the exchange equipment, although similar in principle so far as the switching function is concerned, is designed and equipped to handle the signals from the subscriber in the original digital form (serially coded DC pulses); therefore conversion to analogue form is required only for long distance transmission over the inter-exchange trunks. Voice frequency carrier telegraph is used to effect this conversion.

Because different modes of operation are involved, the information and supervisory signals from the subscriber to the exchange equipment must be unique to the type of system he is connected to. As a result the subset and associated control equipment are entirely

different in the Telex and TWX network; the only similarity is the common use of d.c. dial pulses for transmitting the digits of the called number.

At each subscriber location in the TWX network at least one Bell system provided teletypewriter is required depending on the requirement of the customer. The teletypewriter may be either a Model 33 or 35 (8-level). Although the machines provided on each network are basically similar, the control and leg circuitry are quite different and are therefore, not compatible.

An essential element in both Telex and TWX networks is a numbering system wherein each digit dialed has a significant meaning. The numbering plan for the Telex network has been briefly discussed. It is quite obvious from our knowledge of the numbering plan for direct distance dialling on the telephone network that there is little similarity between the two numbering plans.

Before any consideration is given to interconnecting these two systems, these basic differences must be recognized. Other factors such as accounting, traffic flow, etc. must also be considered and systematic studies be carried out to determine the nature of the problem and applicable approaches to resolve these differences. While it is not within the scope of this presentation to discuss the method by which this interconnection can be made possible, it is apparent from the magnitude of the task that the computer must be an essential element in the transfer, control and processing of information between the two networks.

3.3 Comments from TCTS

3.3.1 Introduction - The following is taken from a TCTS letter dated July 7, 1970.

3.3.2 Technical Comparison of TWX and Telex - At present both systems use electromechanical terminals, however, the codes being transmitted by these terminals vary considerably. Telex uses the 5-level Murray code which is compact and well suited to "telegram" type message traffic. This code makes efficient use of bandwidth, however, it is awkward for use on Data I/O devices due to slow speed and a limited character set. TWX uses the 8-level ASCII code which is less efficient (longer) but it allows for 4 times the number of unique characters which offers some advantage in the provision of data services.

Development trends in machines are toward non-impact printing terminals and CRT type devices. These could be adapted to TWX with little effort. However, due to code limitations, these developments are not likely to be compatible with Telex service. TWX uses basic telephone switching technology which is constantly being improved, whereas Telex uses DC switching technology which is relatively inflexible.

The following is a summary of the main characteristics of each service:

Characteristic	TWX	Telex
Dialing	Dial pulse or Touch Tone	Dial pulse
Supervision	DC Loop	DC Loop

Characteristic	TWX	Telex
Local Loop Transmission	Full duplex frequency shift keyed tone on voice channel	Half duplex D.C. pulsing on telegraph channel
Trunk Transmission	Full duplex frequency shift keyed tone on voice channel	Voice frequency Carrier Telegraph on voice channel (Max. 20 ccts./voice channel)
Coding	8-level ASCII (CCITT 5)	5-level Murray
Usable characters	128	32 (59 with shift)
Parity	Yes	No
Data rate words/min.	100	66-2/3
Signalling rate baud	110	50
Switching	Regular voice network	"Dedicated" network
Numbering Plan	10 digit	6 digit
Billing	Detailed	Bulk

Two types of Telex dialling are used, viz Type A and Type B. Type A (Overseas via COTC) signals by means of the teleprinter keyboard. Type B (CN, CP & Western Union) signals by means of a standard telephone dial.

Consideration of the above comparative chart provides evidence of the difficulties of interconnecting the two Communication Networks. True interconnection of TWX and Telex could only be achieved by providing interface equipment at suitable gateways between the two systems for code, speed, transmission mode and numbering plan conversion.

The alternatives of converting all TWX station, transmission and switching equipment to corresponding Telex equipment or of converting all Telex equipment to TWX equipment would require the abandonment of significant capital investment in the system to be converted and new capital expenditures would be needed for replacement.

In the absence of any significant demand for the interconnection of TWX and Telex services the cost of the alternatives outlined above may not be justified. The typical $45 per month charge for a machine to access the second service may well be the most practical way of providing for the small number of customers who require this flexibility.

3.3.3 Summary - In summary it appears that there are two markets to be served. Telex is designed primarily for message communication - the conveyance of generally unstructured narrative information for personal action, or record - for which it is extremely efficient. TWX lends itself better to the conveyance of precise and highly structured information in compatible record form which is well suited to modern data communications needs.

3.4 Extract from FCC Docket

The following is a summary of technical incompatibilities between TWX and Telex extracted from an FCC docket.*

1. TWX is an analogue system using voice frequency tones to enable the signals to pass through the voice system. There is a supervisory DC signal associated with TWX, as with telephony.

* (Pages 4, 5, 6, 7 of W.U. Exhibit 3, F.C.C. Docket No. 18519)

2. Telex is a digital DC system. Its signals will not pass through a telephone system end to end.
3. TWX teleprinters require a modem (equal in cost to the teleprinter) to convert printer outputs to the analogue tone forms, and conversely.
4. Telex teleprinters do not require a modem.
5. The high quality telephone switches used for switching TWX traffic share common controls with telephone traffic and will not pass Telex subscriber signals through the exchange.
6. The present family of Telex switches uses modifications of telephone switches and these switches will not pass TWX tones.
7. The TWX subscriber can hear call progress tones such as dial tone and busy tone. These tones will not pass through Telex switches.
8. The progress of calls in Telex is indicated by digital signalling at the terminals.
9. Telex multiplexes up to 20 channels in a single voice band, using an effective bandwidth of about 150 Hz.
10. TWX generally uses a full voice bandwidth (3-3300 Hz) per subscriber call.

3.5 C.O.T.C. Input

This organization has for some years maintained facilities at its overseas terminals with which to effect two way code

conversions Telex - TWX. Traffic from overseas originates from Telex terminals. The need for conversion to TWX at Montreal or Vancouver has not developed on the scale that was anticipated. Plans are now far advanced to effect the conversions by entirely different means.

A computer is being installed at Montreal to control Telex switching and to produce billings automatically. This computer will be in service in 1970. An additional software program will be written to effect the code conversions. Thus COTC will always be in a position to respond to TWX or Telex inputs, and interconnection of the two systems would require minor software changes only. COTC experience in this field however would be valuable if any other centers for code conversion in Canada were to be set up. For example in the COTC letter of 21 May, Mr. J. Crispin, Chief Engineer, points out that conversion centers require operator assistance to the subscribers.

PART IV STUDY OF DEVELOPMENTS IN THE U.S.

4.1 Western Union Acquisition of TWX from A.T.&T.

4.1.1 Background - In 1953 a U.S. Senate sub-committee recommended the acquisition of the A.T.&T. TWX system by Western Union (W.U.) and the latter company made an offer to buy the TWX, teletypewriter and telegraph services from A.T.&T. The offer was rejected.

In May 1962, alarmed by certain developments in the intervening years, the F.C.C. initiated an investigation into the conduct of the domestic telegraph industry. The volume of public messages via telegraph had dropped 60%. The loss of this business had placed Western Union in a weakened position to serve as the competition to the telephone giant. There was a desire to find out what responsibility W.U. had for this serious situation.

The resulting inquiry culminated in an important report, F.C.C. Docket No. 14650, April, 1966. This report made recommendations leading to the current acquisition proceedings and it also offered a review of the principles that should guide the development of all forms of record message services in the U.S. except those associated with computer oriented data. The study was completed before computer services had developed to the point which commands attention.

4.1.2 Summary of Reasons Advanced as Cause for Acquisition - The committee expressed concern over the reduction in the facilities being offered for public telegraph messages. This was considered to discriminate against the 'residual user' who could not afford any other service.

It was concluded that means had to be found to sustain this service.

Long term U.S. policy has been in support of the benefits inherent in competition except in a limited field of service which is so affected by public interest as to justify extensive regulation. In fact in the U.S., as in Canada, voice communication was, and is, still the only means of communication firmly recognized to be a natural monopoly. The committee was of the opinion that forcing action had to be taken to maintain even a semblance of competition in the industry in the U.S.

It was considered that the best way to support competition was to ensure to Western Union a large enough segment of the communications market for the company to remain viable. This was foreseen also by the Senate Sub-committee in 1953 which stated, quote "the acquisition of the teletypewriter services (TWX, there was no Telex then) would strengthen and stabilize the financial structure and competitive position of the telegraph system" (operated by W.U.).

Finally the committee foresaw technical advantages and economies resulting from planning for an integrated message-record system.

4.1.3 Protective Conditions - The recommendations were qualified by a number of conditions that had to be established to protect the public interest and the new positions of W.U. and of A.T.&T. These are of interest in considering developments in Canada.

Provision was to be made for the following:

Promotional pricing	Western Union to be required to set up "promotional pricing" schemes designed to test the user interest between the various record systems and hopefully to encourage interest in the public message service which is most accessible to the residual user.
Tariff structure	That Western Union revise its tariff structure to maximize the usage of each type of service according to its value and cost of service characteristics.
No re-entry	Means for preventing A.T.&T. from re-entering the TWX market (but specifically permitting A.T.&T. to combine Data-phone and teletype facilities).
Leasing	F.C.C. to regulate terms for leasing by one carrier to another.
Interconnection	Elimination of interconnection restrictions between A.T.&T. and Western Union on private line services.
Rates	Bell and Western Union each be required to fix rates that yield a fair rate of return on those services that are directly competitive subject to the condition that the carrier with a lower rate and a fair rate of return will control the rate, and will be the rate "bellwether".

4.1.4 FCC Develop Need For Balance in Size Between W.U. and A.T.&T. -

Pricing — The Commission concluded that pricing by Bell for those services directly in competition with W.U. resulted in earnings levels which appeared to be deficient. Thus Bell was relying upon the relative unimportance in its overall earnings record, of the message-record, compared to voice traffic revenues.

Size — The Commission expressed the opinion that "the greatest problem facing Western Union, in such a duopoly setting, is the impediment to its capacity to diversify into areas that involve more and more direct competition with the telephone company. A.T.&T. size constitutes a clear barrier to entry."

Prior Customer Contacts - Bell's pre-eminence in the field of exchange and toll telephone service provides them with prior customer contact. A very pervasive penetration is enjoyed by the telephone company in this respect because additionally the public tends to consider Bell as synonomous to communications services.

Innovation — The financial resources, and the vertical integration of facilities from research lab to production, gives the telephone company a tremendous advantage as an innovator.

Sales — Owing to the imbalance in revenues the telephone company has a great advantage in funds available for

sales promotion. The Commission found that the A.T.&T. sales budget was more than 17 times greater than that of W.U. and that it penetrated both social and business fields. It was considered that the Bell expenditures were sufficient to saturate the market.

Bell has the ability to provide a full line of communications services to meet the growing demand for more versatile communications services.

Access to Financing - The Commission found that there was a vast system of interlocking directorates tying A.T.&T. to the major manufacturing, banking, and insurance interests in the nation. This situation made it easier for A.T.&T. to go 'on the market' for financing.

4.1.5 Supporting Services Afforded By Bell - The Bell system has adopted certain procedures for the delivery of telegrams by telephone and for billing for telegrams telephoned from the customer's premises. For these services Bell receives payment from W.U. The arrangement apparently has been satisfactory to both parties.

The Bell system holds many patents and these have been made available to W.U. without restraint.

The Bell systems owns Teletype Corp., the principle source of teletypewriters in the U.S. No restriction on sales to W.U. has been observed.

4.1.6 Pertinent Opinions of Other U.S. Interests Expressed at FCC Hearings - Hearings were held by the FCC to obtain the views of a significant number of organizations as listed in Appendix A, which formed a cross section of opinion of public and private interests. Brief comments on these submissions follow. Similar views undoubtedly could be obtained in Canada on some of the issues under discussion. Views of the principals are also summarized.

Western Union

1. Would prefer an Umbrella pricing scheme permitting the use of averaging techniques covering several services.
2. Request elimination of what is called 'single source pricing', i.e., cancellation of TELPAK, WATS and other such tariff schemes originated by BELL.
3. * Request freedom for certain interconnections between Bell and Western Union which would be "in the public interest".
4. Would expect an FCC decision to ultimately split the industry between voice and record.

Bell

Generally willing to cooperate with FCC wishes, but would prefer the status quo.

Aeronautical Radio Inc.

Against a voice-record split in the industry.

* Notably interconnection of W.U. private lines through Bell exchanges ending at a subscriber not using Bell terminal equipment.

Communications Committee

Against 'Umbrella' pricing

Allow Western Union to cut any unprofitable service

I.T. & T.

Effect voice-record separation

Defense Agencies

1. Opposed voice-record split
2. More interconnection for maximum flexibility
3. Require maximum diversity
4. No subsidy, direct or indirect to W.U.

General Services Administration

1. Cost of service to be basis of rate-making
   no umbrella pricing
2. No subsidy
3. Free interconnection

American Communities Association

1. Enhance competition between Bell & W.U. by making
   more equal in size, using voice-record split
2. Split Bell up into functional organizations
3. Against 'Umbrella' pricing
4. Require better performance of W.U.

Commercial Telegraphics Union

Separate voice-record facilities. Transfer TWX
to W.U.

4.1.7 Interview with Western Union, February 24, 1970 - On the above date an interview was conducted with Mr. G. Strunz, Assistant Vice President Business Relations, Mr. Cox, Assistant Vice President Communications Systems and Equipment Design, as well as marketing and business officers. This was an informal discussion concerning policy and technical matters. Points of special interest are discussed briefly in the following paragraphs.

Western Union are firmly of the opinion that their organization is not big enough to engage in open competition with the telephone companies and that consequently survival depends upon protection secured by government regulation. The company generally does not wish to provide any services jointly with the telephone companies, recognizing, however, that in some cases, e.g. private wire systems, interconnection is necessary.

According to W.U., competition after the acquisition will be insignificant in the field of TWX and Telex services. There will be continuing competition for private line services, and from other Bell services such as the combination of Data-phone and teletypewriter, although no more teletypewriters, TWX and Telex services will be provided by Bell system companies after the effective transfer date.

It was noted that the present population levels for the two services are:

Telex	32,000 subscribers
TWX	43,000 subscribers

Basic requirements for connection of TWX service has been reached between TCTS and W.U., for a ten year term. TCTS has the option of utilizing W.U. Telex Computer Communications Services (TCCS) for interconnection to Telex systems in the U.S. Code conversion and multiple addressing will be part of the service. Discussions are under way with CN/CP concerning opposite interconnections.

When asked which system W.U. proposed to sustain over the long run the answer was that a changeover to digital technology is foreseen. Reasons given were longer life of terminals, denser circuit packing and particularly savings in modems.

W.U. are committed to take the TWX system out of the A.T.&T. toll system wherever possible. One of their first steps will be to replace Bell microwave trunks with their own.

The F.C.C. have directed W.U. to set up a trial network which will give real time speed and code conversion between the TWX and Telex systems. Delays through a TCTS center vary between seconds to as much as 1/2 hour depending upon the traffic. W.U. believe there is no serious customer objection to such delays.

W.U. permits Telex subscribers to supply their own terminals but only after the first unit.

Considerable discussion took place on the growth and nature of data-oriented services. First a definition of Data processing as distinct from message transmission was advanced by W.U.

to be

> "If the output message reveals the form of the input, i.e. it is possible to reconstruct the input message, then a message service and not Data processing is being provided, and conversely."

4.2 Integration of TWX-Telex in the U.S.

4.2.1 Subscriber Terminals - Subscriber terminals for both services are supplied mainly by Teletype Corp. of America which is owned by A.T.&T. However W.U. state that it is satisfied with service and prices offered by the Teletype Corp. W.U. would be willing to consider any other supplier which is prepared to make a competitive price/performance bid. Integration will not result in a common new terminal suited to both TWX and Telex. Units now offered by the Teletype Corp. have already been designed to this end as far as is practicable. Very many models are involved, as TWX and Telex both offer a variety of features which can be tailored to the subscriber's order.

In the Thomas F. McMain exhibit reference customer provided terminals, it is stated that a split will be made between TWX "Prime" service and public exchange service. In the "Prime" service signalling frequencies are inverted and only "Prime" Bell system subscribers can communicate. These subscribers may provide their own terminals and operate the system as a private network but modems must be supplied by W.U. until acquisition.

When acquisition is completed W.U. will permit customer provided modems which must be isolated from the network by W.U. isolators which will generate necessary control signals.

After acquisition, W.U. will develop facilities to allow subscribers to attach their own terminal equipment to W.U. public exchange networks. The technology is not complete as yet. Problems include code and speed compatibility, answerback compatibility, other electro-mechanical compatibilities and adequate maintenance (of customer terminals). W.U. also stipulate that use of customer provided modems will be subject to the following:

1) Only approved types of terminals will be permitted. (This would require an independent approval agency to be set up).

2) Network control and interfaces will be supplied by the carrier.

4.2.2 Systems - Consideration of referenced documents and discussions with W.U. officials confirm that all interconnection planning is based upon the use of central computer processors, a build-up of Data services, and conversion to digital transmission techniques. The long range objective is for a totally integrated, data oriented, low and high speed message record system. Many of the details of the plan will have to be worked out only as the changing economics of new switches and of digital transmission become more evident.

The multiplicity of services being offered as between public message, teletype message, various forms of Data, when compounded with the need to provide international services links (Overseas, Canada, Mexico) typically results in a matrix of many possible forms of interconnection which have to be supplied on a national scale. This makes for complex computer processor programs as well as complicated distribution networks.

Among the functions to be provided by the computers, will be store and forward, multiple address, code conversion, repeat calls and many others.

After the acquisition of TWX, W.U. intends to supply Telex Computer Communications Services (TCCS) to a certain class of TWX subscribers. This will permit message relay services for TWX to TWX, TWX to Telex, and TWX to telegram. TCCS will be a computer aided facility.

Planning for the changeover in the U.S. will provide for the continuation of several types of service some of which do not exist in Canada. W.U. intends to remove the TWX from the telephone company's switching plant. The fact that W.U.'s switching plant is loaded now in many areas means that integration can only proceed as fast as new common plant switching equipment can be secured and

installed. There would not be an exact parallel in Canada under similar merger circumstances since the ratio of Telex to TWX in Canada is about 4:1 whereas in the U.S. it is closer to 1:1 and therefore the present TWX cannot be simply scrapped or diverted to other services in the U.S.

Only a detailed after-the-fact study of the technical methods adopted in the U.S. would be of benefit reference any integration proposal for Canada. There is therefore no purpose to be served in recording more than the general points that have been discussed.

For an interim period at least, W.U. expect to service Data over their standard Telex facility. The standard speed will be upped to 100 w.p.m. from 66 w.p.m. and the ASC11 code will be employed. All short haul and trunk routes will eventually rely upon digital techniques only, for high speed transmission of Data.

4.3 Future of the Technology According to Western Union*

Western Union are of the opinion that provision for future services will make mandatory system designs which will include high speed digital transmission techniques, common signalling channels, and time division circuit technologies in the switching equipment. Very rapid call set up times will be made available. It

* Reference F.C.C. Docket 18519, pages 9, 10, 26

will be possible to engineer the system on a delayed call basis rather than a lost call basis.

Western Union believe that "Communications switching centers should be essentially transparent to codes and speeds and be insensitive to traffic constraints such as call holding times. That is, if an expandable data-record communication system is to be achieved, the switching center must not be designed on the basis of telephone voice switching center requirements, nor can it be a development produced by a simple modification of the present type of voice switching system (as are the present Telex and TWX switching centers). The communication switching centers must be designed on different principles. They must be oriented toward the special requirements of the data world".

Western Union now have a 7900 mi. nationwide Electronic Data Communication (EDC) network. In a recent filing with the F.C.C. for permission to extend a microwave system 400 mi. from Cincinnati, Ohio to Atlanta, Georgia, it was noted that the system would provide 216 voice frequency analogue channels and 165 digital data channels.

4.4 Interview With Senior A.T.&T. Staff

In a meeting with V.N. Vaughn and P. Muench at A.T.&T. Headquarters, April 21, 1970, the following observations were made.

The telephone companies regard the TWX acquisition ruling as giving Western Union five years to get established in message-record and low speed data without competition from Bell. During this 5-year

period except for not offering switched Teletypewriter service at less than 300 bps, Bell will be actively adapting their services to suit all other needs of data customers. They already provide 50 kbps private line service via group band 48 kHz facilities as well as a limited (4 cities) switched 50 kbps service. Plans are being made to expand the switched 50 kbps service to cover more Metropolitan areas. The use of selective routing and the newest crossbar switches in this service allows connect times (end-of-dial to start-of-ring) averaging about 3 seconds on an interoffice call.

They have formed a new data group at Headquarters specifically to put more intensive effort on medium range (5-10 years) planning of new data services. The proposed new service includes a private line digital data service based on present and planned digital transmission systems to be used in the telecommunications network. The group is also studying a variety of switched services including some in which the charge would be based on the amount of the information transmitted, e.g., the number of characters, rather than the length of time the connection was held up. Mr. Vaughan expressed the view that standard 50 baud Telex will never qualify as an important data medium. He had heard of intensive studies in Europe to determine how to integrate Telex with Data in new networks. Discussion on a suitable definition for "Data" was inconclusive. A.T.&T. vouchsafed that about 50% of "information" transferred today - allowing for the excessive redundancy in speech, is done via Data services. However only about 5% of the telephone plant is occupied at any time by Data. With the introduction of picturephone and other video services it is unlikely that Data will ever absorb more than 5-10% of the telephone plant.

4.5 Relation of U.S. to Canadian Situation

4.5.1 Background U.S. Policy - The U.S. Government, through cabinet directives and its agent the F.C.C., have recently taken a number of significant steps to liberalize the regulations concerning telecommunications. The effect has definitely been to widen the doors to competition and to reduce the telephone company monopoly. An early break was the Carterfone case resulting in removal of restrictions on the use of customer supplied terminal equipment. Recently MCI, a new potential carrier, has been granted a licence to install and operate microwave systems spanning one-half of the continent. Currently also an application is being considered from a new company, DATRAN, which wants to build a microwave system to transmit "Data" only. And the F.C.C. is effectively building up Bell's principal competition through forced merger of the TWX-Telex. Note, however, this is not intended to be the beginning of a complete voice-record split between Bell and W.U. in a duo-monopoly situation, otherwise, the DATRAN filing would not be considered at all.

4.5.2 Corporate Relationships - Western Union has had a natural cross-over with CN/CP Tel since both sell Telex services. The relationship has been a pragmatic one. It has been shown that Bell Canada will obtain similar support from Western Union and certainly it has already been established that W.U. wish to make provision in their integrated system for Canadian-U.S. traffic. As a result of these relationships Canadian carriers will enjoy equal opportunities for interconnection with the two U.S. systems.

4.5.3 Economics - The arguments advanced by the FCC on the score of monopoly economics may be as cogent in Canada as in the U.S. The disparities in capabilities for sales promotion, pricing practices, and particularly for innovation, are evident in Canada. The fact is, that a small monopoly operating in the shadow of a much bigger monopoly is constantly under pressure and generally is in an unstable position, unless firm government regulations give it extraordinary support.

4.5.4 Finance - There are major differences between the U.S. and Canadian situation in the financial realm. Bell Canada has been pushing an expanding bow-wave of debt ahead of it for years. Currently it is having difficulties in obtaining new financing which are related to world financial conditions and to its profit record. The CN/CP is a working alliance and does not resemble W.U. One half of the alliance is a crown company, the other half, the CPR, is a giant conglomerate. The ability of CN/CP to raise funds has probably never been fully tested. One may ask however, how far can the Government go with direct financial aid to support competition to the telephone monopoly? It is possible that the Bell Canada system does not have the financial advantage that A.T.&T. have had in the U.S.

4.5.5 Considerations - It is clear that the U.S. government has concluded that there was too great an imbalance between the major communications carriers. As we have seen, the FCC has moved effectively to guarantee an accelerated growth for W.U. through expansion of the TWX-Telex services which have a great future. Concurrently the FCC has moved to block the growth of the Bell system by opening up the continental

microwave routes, and particularly so, since these are to be used for Data transmission. This tends to limit Bell growth to voice/ videophone and its derivatives, whereas many experts envisage the value of Data traffic to eventually surpass these. It would be unwise to assume that A.T.&T. can be counted out of Data transmission services, on the contrary A.T.&T. are organizing a long range program to start with services like DATAPHONE and eventually to win a major share of the market.

In Canada, the Government has already given support to the concept of inter-carrier competition through direct or tacit support of the CN/CP Telecommunications alliance. The degree of competition however has limiting factors similar to those which were observed in the U.S. by the F.C.C.

The development of the new integrated services in the U.S. is to be keyed-in to computers as we have seen. Very considerable sums will be invested in computer programs for system control. Since there is to be a cross-over between U.S. and Canadian systems the technical inter-relationships could be simplified if the Canadian service was unified. It would be advantageous also if W.U. knew the Canadian plans now for development of the services on a long term basis, because as their own system develops, their computer programmes are going to get more and more complex, and costly to change. In fact if different computers were used on either side of the border it would further complicate the programming problems to the point where it could be economically impractical for W.U. to serve Canadian requirements completely.

4.5.6 Conclusions - (1) The U.S. Government has legislated for the institution of a single Record-Message system.

(2) This system will be extended in function by W.U. to include Data transmission.

(3) The telephone companies will remain in the field via medium and hi-speed switched data service.

(4) Whereas the W.U. system effects a voice-data split, those media will be developed in a parallel series sequence in the next two decades.

(5) Integration of TWX-Telex and other Record-Message, Data services in the U.S. is being planned on a Continental basis. This is being done without benefit of an expression of a Canadian government position on related long term policies regarding similar systems in Canada.

PART V TCTS POSITION PAPER ON TWX-TELEX INTERCONNECTION

The entire text in this part is a verbatim extract from the TCTS paper prepared for this study.

Quote: "TWX and Telex were initially developed as teletype message services. Since CN/CP entered the market place well in advance of the TCTS Companies, they had a large user group already in existence at the time TWX was introduced. To this day Telex is the most widely used vehicle in Canada for switched teletype message service.

Although TWX is quite capable of providing teletype message service, it has also evolved, because of its technical features, as an excellent vehicle for supplying data services. While Telex has grown to acquire significant gains in the "random message" business, TWX has evolved into a number of in-house customer systems. Recent studies indicate that approximately 80% of the TWX terminals, are used primarily for in-house low-speed data carrying purposes rather than for random message capability.

The TCTS Companies feel that this factor is of prime importance to the subject of TWX-Telex interconnection. The 8-level code and 100 words per minute speed features of TWX have strongly established TWX as a basic introductory service for users of data services. Having this offering has allowed the telephone carriers to provide their data customers with basic service initially and grow with them as their more sophisticated needs evolve. Of considerable importance in this area is the fact that once a data user is committed to a specific data format within his business, he becomes economically committed to systems design, computer language, speed of operation, business forms, etc., making it

extremely expensive and wasteful in resource allocation to change.

The late arrival of TWX into the market place permitted the inclusion of several features in its system design which have proven most attractive from a data use standpoint. Although there is some overlap, two different and distinct markets for TWX and Telex now exist. A recent study gives some statistical evidence of this fact in that only 1.5% of all TWX and Telex users have acquired machines to access both networks. This factor cannot be considered conclusive because of other differences in rates, message length, cross border concerns, etc. However, for the price of $45.00/month, a user of one service can acquire a terminal on the other network. To date less than 2% of all users have done so.

In evaluating interconnection of the two networks, there appear to be a number of alternatives to consider.

- Establish a point of interconnection while maintaining two prime suppliers.
- Amalgamate the two services under one carrier.
- Retain the current status.

Regarding these alternatives the following comments should be considered: -

- Carriers in the data business need an entry offering to the low speed data market. To exclude one carrier from this field would give an unfair competitive advantage to the other. Data users become economically committed to a particular system and are naturally reluctant to change once committed.

- The costs associated with making the two networks technically compatible will be high. Interconnection costs are directly related to speed and code conversion. Interconnection can only be effected at locations equipped to receive traffic in the 8-level ASC11 code at 100 words per minute on voice grade facilities and retransit it in the 5-level Murray code at 66 2/3 words per minute on telegraph grade facilities and vice versa.

  This type of problem is serious enough in the case of international traffic which flows through a relatively small number of recognized border-crossing points or "gateways" which provide natural locations for the conversion. In the case of domestic traffic between carriers who serve the same territory, the converter locations would have to be numerous or a large proportion of the traffic would have to be carried twice, i.e. back-hauled, over the same route.

  In Canada with its population distributed in a strip approximately 4,000 miles long and 2000 miles wide, the "back-haul" could span great distances (e.g. a TWX to Telex call with both stations in Vancouver routed via a converter located in Toronto).

- Should the cost of interconnection be paid by those who use both networks or by spreading the costs across the general body of users? Since there is little evidence that a high degree of demand for interconnection exists at the present

time, a general rate increase to pay for the cost of interconnection would not appear to be in the best interest of the general user.

- Interconnection would introduce billing and division of revenue problems because of variances in the rating structures of the two services. Different timing allowances, calling areas, speed of transmission, etc. contribute to this problem.
- Single ownership of the two networks would not solve the foregoing problems.
- A decision to retain one service only, would require the abandonment of the investment in station equipment and central office switching gear for the discontinued service. Furthermore, an additional investment would be incurred to replace those services provided by the discontinued offering.
- Retaining the current status -
    . provides for the maintenance of a degree of competition which had stimulated market development and increased user choice and option.
    . permits each carrier to market a full range of data services.
    . avoids the high cost of accommodating technical interfacing and conversion related to interconnection.

In conclusion it is the recommendation of the TCTS Companies that the TWX and Telex offerings of the two carriers should not be interconnected or combined.

PART VI WHAT WILL HAPPEN IF THE GOVERNMENT DOES NOT INTERVENE

6.1 Future Development of Telex & TWX

We have seen that Telex has a growth rate of 15% annually. Advancement of the TELENET computer controlled service is in direct response to the rising demand. TELENET will have store and forward switching, capacity for multiple address, and other features similar to requirements for a Data Transmission net. The service will include Data-Telex. It is possible that Telex will place increased emphasis in favour of the ASCII code to increase the potential of the system for low speed data service, as well as Record-Message. It will be seen in the following text that CN/CP Tel are planning to vigorously promote their Data Transmission facilities. These obviously can be developed to maximum advantage as an integrated system with Record-Message services.

TCTS state that about 80% of the TWX terminals are now Data oriented. It would appear that it is as a low speed Data transmission service that the system has a future. The telephone companies recognize this now in their sales policy, which is to sell TWX as a Data system. The Multicom data transmission system (introduced in 1970) provides a necessary extension of the speed range of Data service offered by TCTS.

6.2 Is Non-intervention Possible?

A competition is developing between TCTS and the CN/CP Tel to decide which is to establish the major Canadian Data transmission system and to benefit from the sale of its services.

Since the TCTS system now enjoys advantages which CN/CP Tel claim are rooted in monopoly, and are similar to those discussed for A.T.&T. in the U.S., it can be expected that CN/CP Tel will press for government intervention to establish a different environment. Keynotes in their claims will be access to the local switched public telephone network for private line voice, and low-medium speed Data, and protection for a public integrated Message-Record-Data system. Details are advanced in the following chapter.

6.3 Conclusion - It is improbable that the Government will wish to ignore these issues in which there are strong elements of national policy. Decisions will have to be made which will have a decisive influence on the development of the economy. Therefore it can be reasonably stated that a course of non-intervention is not open to the Government. Thus the first of the Terms of Reference is seen to be a hypothesis which can be discarded.

PART VII CN/CP TEL CARRIER TO CARRIER INTERCONNECTION PAPER *

7.1 Foreword

In considering the matter of carrier to carrier interconnection one must be guided by the basic premise underlying policies and laws governing Canadian industry and commerce; namely, unless inconsistent with public interest, competition is to be encouraged and relied upon to regulate the economy. Competition affords the most reliable incentives for innovation, cost reduction, efficient resource allocation and consumer protection against high prices and inferior products and services.

Most of the Canadian economy fits the competitive pattern. The pattern is not the classical pure or perfect competition model but a structure ranging from two to thousands of suppliers in respect of most products and for most customers, depending on particular technological and market circumstances. Entry into markets by new producers and new suppliers is permitted and encouraged. The purpose of the Combines Investigation Act, which prohibits restrictive trade practices, is to prevent the suppression of competition. In addition, the Criminal Code of Canada, contains provisions which declare as crimes against society the practice of certain restraints in industrial competition. Courts have long held in cases under these statutes that the public has a vested interest in the maintenance of competition.

National policy tends to minimize price regulation and other direct interference with free market forces and the economic initiatives of individuals and companies. Only where workable competition

is not effective, or the result of workable competition is not in accord with public policy, is there direct government interference with market forces.

Telecommunications Services in Canada are presently provided by two main Carrier groups, the telephone system and CN-CP Telecommunications. Public telephone service is almost exclusively provided by the telephone system and public telegram service by CN-CP, with both groups competing for other services, mainly private services. Because of the size of the public switched telephone network (representing approximately 85% of all Telecommunication Service requirements) and the fact that CN-CP is denied access to this network for local distribution of its services, competition is ineffective. Nevertheless we advocate retention of this structure for the Telecommunication Service industry with modifications, described in this report, to strengthen competition.

7.2 Summary

Accordingly CN-CP submit:

(1) Two carrier competition in Canada is desirable for certain sectors of the Telecommunication market. Mainly these sectors include:

(a) Dedicated private line service: voice, digital record, facsimile and telemetering.

(b) Broadcast network service: audio and television.

(c) Line switched service: digital record in excess of 600 bauds (the minimum speed at which digital transmission on a voice bandwidth may be justified), private voice and facsimile.

(d) Message switched record services for private use. The number of Telecommunication Carrier groups, presently the telephone system and CN-CP, offer the best compromise between economies of scale and competition and should be continued at this time.

(2) There should continue to be a monopoly in public telephone service.

(3) There should be a monopoly in public record service, whose integrity, reliability and viability should be preserved, to provide:

(a) Telegram services.

(b) Line switched (including equivalent quasi real-time systems) record services at terminal transmission speeds to 600 bauds. (Speeds which can be accommodated economically by telegraph circuits without resorting to a full voice bandwidth).

(c) Message switched record services involving store and forward switching techniques and operating at any speed dictated by current practice and the state of the art.

The public record system should include existing TWX, Telex, Data Telex, TelTex and Telegram services in an integrated network.

(4) In the public interest the monopolistic services will require regulatory constraints which are not needed for competitive services. In the latter case regulation must be sufficiently broad to promote fair and effective competition.

(5) To achieve fair competition regulation must prevent economic strength derived from protected markets in the monopoly field from being used by carriers to engage in unfair or destructive practices vis-a-vis other carriers in the competitive field. It

must preclude cross subsidization among various classes of service and in particular between monopoly and competitive services. Exceptions should be allowed for services to remote areas under development where the total demand for service is small (e.g. Yukon and NWT). In such cases all resources must be pooled to provide viable public services at reasonable prices.

(6) To achieve effective competition and to avoid wasteful duplication of local services, carriers must be allowed to continue to acquire local distribution facilities from an other carrier in order to access subscribers to their services. Furthermore to prevent monopoly power from denying competitive opportunities in private line services access must be allowed to local (metropolitan) monopolistic switched services. Such extensions and/or interconnection to local switched distribution systems should be provided at regular tariff.

7.3 The Rational of Limited Competition in the Canadian Telecommunication Services Industry

General - The rationale of limited competition stems from two premises. First, competition will insure that as the state of the art advances, users of telecommunications will enjoy continually improved and modern services at reasonable prices, with minimum government regulation. Second, limiting competition will permit the achievement of economies of scale in the Canadian environment to guarantee the attainment of this objective.

Benefits of Competition - The principal benefits of competition in the

Telecommunication Services industry as opposed to a monopoly are:

1) Stimulation of efficiency and encouragement of innovation -

   Competition affords the most reliable incentives for product and production innovation, cost reduction and efficient resource allocation -- that is, production at the level that will satisfy all consumers for whom the utility of a service exceeds the cost of supply.

2) Promotion of quality, reliability and good service -

   The possibility exists of compromise between service quality and reliability, and cost, but generally competition creates incentives for improved performance consistent with costs. These issues can be resolved in the market place.

3) Customer satisfaction from having a choice of suppliers -

   From the variety of services offered by competing carriers the customer can choose those which are tailored to meet his particular needs and is free to move to an alternate supplier if the service turns out to be less than expected.

4) Responsiveness of suppliers to new and specialized customer needs -

   Often, and especially in times of rapidly changing service needs, the services offered by monopoly carriers are highly standardized and relatively inflexible and impose an extra cost to some consumers-- the cost of adjusting specialized

demands to general service offerings. An alternative supplier can:

1) offer specialized services to particular groups of customers permitting cost savings and avoiding waste;

2) use different and perhaps more advanced technology especially suitable for specialized or new service requirements;

3) be more efficient and faster in introducing new services.

5) Lessening of the need for government regulation and control - The levelling factor of competitive pressures generally lessens the need for regulation to achieve the broad policy goal of a wide availability of Telecommunication Services at fair and equitable prices.

6) Dispersal of economic control and decision making. Provided that there is effective competition with adequate regulatory controls to preclude cross subsidization and predatory pricing, economic control of the industry by one carrier can be avoided, widening the scope for individual and company-level initiative in decision making processes.

Limited Competition - The Telecommunication industry is characterized by a distinct set of economic conditions:

1) It is capital intensive and becoming increasingly so.

2) It has high threshold or constant costs and low marginal costs.

3) It has a high rate of technology change and obsolescence.

Because of these conditions and the inherent economies of scale, the industrial organization choice for the Telecommunications industry must fall between limited competition and monopoly. We believe that the course of limited competition is desirable in the public interest and compatible with the historical patterns Canada has followed in the public utility and transportation fields. The airlines and railroads serve as prime examples.

The present structure of the Telecommunications industry which consists essentially of two competing groups reflects the choice we advocate. The two groups are: CN-CP as one group and the telephone system which includes Bell Canada and provincial and regional telephone companies as the other. Ownership in the industry is predominantly private with one Federal and three Provincial Government owned carriers. Public telephone and public telegram services are operated as monopolies by the telephone system and CN-CP, respectively, with competition between these two Carriers in other service areas.

This carrier configuration has performed well and has met Canadian needs with wide availability of essential services at acceptable prices for the user. In the public utility sectors both carrier groups have been responsive to their public duty in their rate making policies. They have been able in the past to raise the necessary capital to provide the services needed and the performance of the present systems attests to the quality of their services. There is no evidence to suggest that the present two-competitive-group system will not be able to adquately meet anticipated telecommunication

needs in the future, given the recommendations proposed herein.

Our recommendation for limited competition in the telecommunications industry is in conformity with accepted Government policy in the telecommunications industry and has its roots in similar national policies adopted in the past. Any departure from the existing industry structure must proceed with caution. It should define where the present system is failing and make changes only when there is no doubt that the changes will in fact correct such failings while minimizing undesirable side effects.

We reiterate that competition in the telecommunications industry should be limited to the number of suppliers necessary to realize economies of scale, efficient use of the frequency spectrum and to effect other efficiencies that will result in services becoming available to users at least cost. In view of present market sizes and technologies of production, the number of Telecommunications Carriers in Canada at this time should be limited to two.

The question of airline competition in a limited two-firm market was examined in a study by S.F. Wheatcroft completed for the Canadian Government in 1958, entitled "Airline Competition in Canada". A conclusion of the study was that the possible benefits of competition between two suppliers in stimulating more adequate and efficient service, technological progress, and traffic development and in providing the satisfaction of choice to consumers and a yard-stick for measuring efficiency outweighed the risk of competition's raising cost levels through stimulating over-capacity. The principal

recommendations contained in the Wheatcroft report respecting competition were implemented by the Government and indeed have been expanded steadily since that time.

One of the major issues examined in the U.S. "President's Task Force on Communications Policy" dated December 7, 1968 was "determining the proper roles of monopoly and competition in the provision of telecommunication services". The study concluded: "The premise of our law with respect to industrial organization is that competition should be the rule, and monopoly the exception. Monopoly must be resorted to where a single seller is desirable as a consequence of conditions that permit him to offer most economically the full supply required by the market....In the field of domestic telecommunications, our public telephone service is such an example". In areas of the telecommunications industry "which do not, or need not, affect the integrity of the switched public message telephone network", the report recommended the removal of unnecessary restrictions on competition.

Although we do not recommend for Canada's small market the freedom of unrestricted entry proposed in the Task Force report, we do accept the principle underlying the recommendation; namely, that the achievement of economies of scale in the provision of particular Telecommunications Services do not require, for efficiency, a single supplier and that competition among suppliers will best satisfy consumer needs.

7.4 Monopoly Areas in Telecommunications

Except in certain areas of Newfoundland and the North West Territories which are served by Canadian National Telecommunications, public telephone service in Canada is provided by the member companies of Trans Canada Telephone System and other independent telephone companies. These telephone companies provide service in contiguous territories, consistent with their charters or enabling legislation and interconnect with one another to provide long distance telephone service. Except as indicated, CN-CP Telecommunications does not provide public telephone service and is not permitted by the telephone companies to interconnect with their switching facilities to extend any of its services.

We accept the position that it is in the public interest to have an integrated telephone system made up of individual companies offering public telephone service in a number of contiguous areas. Competitive offering of such service would involve an uneconomic duplication of facilities.

We contend that under present conditions the public telegram service is best provided by a single company. Because of rapid declines in usage, currently averaging approximately 6% per annum (in part due to the increased use of TWX and Telex services), business has reached a level that can hardly support one carrier. It was this situation that caused Canadian National and Canadian Pacific to abandon competition and pool their telecommunications resources to achieve all possible economies.

We also contend, for the same reasons applicable to public telephone service, that there should be a single carrier responsible for the provision of public record services, that is record services to which any member of the public can subscribe and by means of which any subscriber can transmit or receive record traffic to or from any other subscriber.

These record services should include specifically the existing TWX, Telex, Data Telex, TelTex and Telegram services, integrated into one network. Generally, the record carrier should have the exclusive responsibility of providing to the public:

(a) Telegram services

(b) Line switched (including equivalent quasi real-time systems) record services at terminal transmission speeds up to and including 600 bauds. These are speeds which can be accommodated by telegraph circuits without resorting to a full voice bandwidth (nominally 4000 H3), thus reducing costs by avoiding the unnecessary use of frequency spectrum.

(c) Message switched record services involving store and forward switching techniques and operating at any terminal transmission speed as dictated by current practice and the state of the art.

The 600 baud limit is specified in item (b) not only to reduce costs and conserve frequency spectrum, but also to prevent the establishment of a competing switched service over the public telephone (voice) network by merely changing the name of the TWX offering. This does not preclude use of the public telephone system by subscribers for the

carriage of digital transmissions, except that such use should be subject to the same tariffs and rules as apply to the public local and long distance telephone services.

Item (c) seeks a monopoly of message switched services at any speed, to the extent only that the use of store and forward techniques are employed in the provision of a public record service as defined above i.e. that any subscriber to the service can transmit or receive record traffic to or from any other subscriber.

Similar to public telephone service, competitive offerings of public record service would involve an uneconomic duplication of facilities which is not in the public interest.

There is significant demand for public record services in Canada as evidenced by the size and growth of the Telex network. By the integration of existing TWX, Telex, Data Telex, TelTex and Telegram service the public will benefit from:

1) Increased call potential by bringing together the now segmented switched record services.

2) Access to public telegram service presently not available to TWX customers.

3) Cost-of-service savings.

4) Greater development of the public record system in terms of new services.

From the Carriers point of view, benefits accrue from:

1) Increased potential and stability in earnings.

2) Increased potential to plan and innovate services and pricing policies within an enlarged market.

3) Ability to make more effective use of public telegram service as an integral part of the public record system.

Some, but not all, of these benefits could be realized by interconnecting TWX, Telex, Data Telex and TelTex services as they exist. Interconnection is technically feasible by code and speed conversion. However separate ownership would not permit flexibility in planning controls and pricing policies or produce the potential cost-of-service savings possible in a fully integrated system, and is therefore an unsatisfactory solution. Specifically, it is recommended that TWX service should be absorbed by the Telex network as soon as a service similar to that available to TWX customers, can be provided. More particularly it is proposed that CN-CP assume the exclusive responsibility to supply line switched record services as a public offering for all transmissions at speeds up to and including 600 baud.

To effect integration of record services up to 600 baud a code and speed translation capability must be established. Having this capability and in recognition of the desirability of further integration of other digital services into a public record system, it is recommended that CN-CP assume exclusive responsibility for the use of store and forward switching techniques in the provision of public (record) services.

CN-CP have consistently demonstrated initiative and leadership with development of switched record services. They first recognized the public need for such service by introducing Telex in 1956, six years ahead of TWX, and for many years previously had been designing and installing systems for telegram traffic and private use. Computer based store and forward services were first offered

by the CN-CP in 1964. They are now operating four independent systems serving nearly 1000 lines and 3000 outstations operating at speeds ranging from 75 to 2400 bauds. These systems include over 500 million characters of mass storage. Two additional store and forward systems will be placed in service before the end of 1970 and plans are already being made for new Telex offerings and the integration of Telex, Data Telex and other digital services using computer oriented switches.

Monopolies in public record service as previously defined, owned and operated by CN-CP, would promote healthy intermodal competition with the monopoly in public telephone service. It could stabilize and strengthen CN-CP's financial base and allow plant development to lessen, in part, the advantage held by the telephone system in their ability to realize economies of scale. In addition the exclusive responsibility to supply public service involving the use of store and forward switching techniques provides for interconnection with, a similar system being developed by Western Union in the United States.

7.5 Competitive Services

The monopolies proposed in Section 7.4 are not inconsistent with the position favouring competition within the Telecommunications industry. Benefits flow not only from strong public telephone and record services but from healthy intermodal competition.

For some telecommunications services the special

economic and technical considerations that overturn the presumption in favor of competition over monopoly are not present. Thus, where communication service needs do not require access on demand to any one of millions of points, some of the special problems relating to system optimization, integrity and reliability (that make the case for monopoly in public service) no longer operate. In all such circumstances the communications services can be more responsively and efficiently provided by competing suppliers.

In particular we believe the following communications service areas should be served competitively, that the number and size of competitors should be limited so that each can realize full economies of scale, and that the limited competition should be subject to government regulation which precludes cross subsidization and protects against unreasonable prices:

1) Dedicated private line services: voice, digital record, facsimile, and telemetering
2) Broadcasting network facilities: audio and television.
3) Line switched services: digital record in excess of 600 bauds (the minimum speed at which voice bandwidth may be justified from the standpoint of economy and spectrum conservation), private voice and facsimile.
4) Message switched record services for private use.

In these areas competition already exists between the telephone system and CN-CP.

All of these services are effectively private services in that they are leased by a person for use between specific terminals. Even the line switched services have restricted connectability, limited to compatible terminals and the speed capabilities of line facilities.

The telephone system has been handling line switched digital record services on their public telephone network, at speeds within its technical capability. We contend that services at speeds up to 600 baud can be more efficiently handled on less than voice band facilities and should be integrated into a public record system. This does not preclude public telephone service from being used by subscribers for this purpose, (or any higher speed) as long as tariffs and rules for public telephone service apply.

CN-CP offers its Broadband network service for data transmission speeds in excess of 600 baud. Unlike the public telephone network, Broadband provides for simultaneous two-way transmission and for some time has been offering switched services at speeds up to 4800 baud on specially conditioned voice band facilities. However, the network has been designed to switch various bandwidths up to 48 KHz, for which data equipment is available to handle 50 kilobaud speeds. The continuing growth of this network since its inauguration in 1967 has demonstrated its acceptance by the business community and is a prime example of why a competitive environment should be continued in the line switched broadband services.

Without terminal compatibility, code and speed conversion of digital traffic on these networks is necessary to allow

record traffic to flow from a terminal to any other terminal. This involves storage and retransmission (store and forward). Our position is that the application of this technique to provide a public record service should be restricted to preserve the integrity, reliability and viability of such a service. We moreover believe that CN-CP should have responsibility for the service in view of its complementarity to the low speed record service for which a monopoly is proposed to CN-CP. Moreover, a CN-CP monopoly in store and forward service will help provide a business base to the vastly weaker competitor in the telecommunications area.

Conversely the application of such techniques for private message switched record services should be competitive. Requirements are developing rapidly and the public will benefit from active competition where competitors must use every resource available to capture a fair share of the market.

It is significant that the requirement for data transmission services in Canada is at the threshold of significant development. The potential for added competition in telecommunications from developments in this area is great. As a result of social and technological changes already on the horizon, there will emerge in the 1970's and 1980's an ever increasing requirement for customers information processing and storage and retrieval services. By 1975 experiments will have begun and some systems installed permitting home owners to access computers for various purposes.

Many benefits will accrue from active competition provided that the competition is effective. In this respect it is important that Carriers be precluded from taking advantage of favourable returns from monopoly service areas to subsidize marginal or loss situations in competitive markets. To this end there is a need for effective (but not restrictive) regulation. It is important also that no undue advantage be taken of monopoly situations to create unequal opportunities for competitive services. To this end there is a need for policy decisions concerning carrier to carrier interconnection of facilities and services.

7.6 Regulation

As we have seen there are two primary Telecommunications Carriers in Canada today, the system of telephone companies and CN-CP Telecommunications. In 1968 all Carriers grossed 1.385 billion dollars in revenue of which over 90% accrued to the telephone companies, primarily from monopolistic telephone services. In the order of 150-200 million dollars was derived from other services, largely private line services which is a major competitive segment of the Carriers' business and from public telegram and cable services. The following are statistics taken from the 1968 Dominion Bureau of Statistics report (DBS) and the Carriers Report on Telecommission Study 2(e).

Canadian Telecommunications Industry Revenues 1968
(Millions of dollars)

Telephone Companies

Exchange telephone services, directory advertising, income from investments, local private line and service charges.	760

cont'd

Telephone Companies (cont'd)

Inter exchange switched network long distance and TWX message charges	430
Wats, inter exchange private lines, message switching data services and Telpak	78
CN-CP	
Public telegram, private line services, Telex, and Broadband	83
COTC	30
Others	4
Total	1,385

At the end of 1968, DBS also record a gross capital investment in excess of 5 billion dollars for the telephone system compared to 400 million dollars for CN-CP. Since the two competing carrier groups cover essentially the same geographical area it is clear that competition is nominal and ineffective.

The fundamental principle of regulation should be that the rates charged for a Telecommunication Service earn a fair return, at least sufficient to meet the costs of provisioning. This should not preclude rate averaging in the case of a particular service provided that it is in the public interest.

With a system of regulation based on the criterion of fair return on the entire rate base of a Carrier, such as applies to Bell Canada today, the possibility always exists that the Carrier could use its superior position in sheltered markets to cover losses or marginal profits in competitive sectors. We contend this is not in the public interest.

In this regard it is worth noting the results of the Federal Communications Commission's Seven-way Cost study undertaken in the United States a few years ago in an effort to determine the earning levels of particular interstate services. The Bell System was requested to undertake an extensive inquiry to ascertain its interstate investment, revenues and expenses and net earnings, among seven categories. Detailed procedures were developed for the allocation of investment and expenses among particular categories of service, generally based on the principle of relative usage. Analyzed in terms of total day usage for a 12 month period from Sept. 1, 1963 to Aug. 31, 1964 the following results were reported:

Category of Service	Net Operating Revenues (thousands of dollars) (A)	Net Investment (B)	Percentage of A to C	Percentage of A to B
Message Toll Telephone	426,723	4,286,702	86.7	10.0
Teletypewriter Exchange Service	6,795	237,584	1.3	2.9
Wide Area Telephone Service	30,684	303,004	6.3	10.1
Telephone Grade Private Line	17,137	362,758	3.5	4.7
Telegraph Grade Private Line	4,414	313,324	0.8	1.4
Telpak	1,662	564,742	0.3	0.3
All Other	5,174	490,292	1.1	1.1
Total	492,589 (C)	6,558,406	100.0	7.5

Reservations or limitations believed pertinent to the findings and set forth in subsequent testimony, were noted by the examiners but did not invalidate or alter the success with which the study achieved its intended purpose. It was clearly evident that only the percentage of net revenues of message toll telephone and Wats to net investment exceeded the percentage of total net revenues to total net investment and that all the remaining services fell below the average return. Western Union charged that the Bell System used its monopoly voice services to subsidize its competitive telegraph and private line offerings.

Clearly, effective competition cannot exist under such conditions in Canada or in the United States.

7.7 Interconnection

Telex and TWX - As we have seen in Section 7.4, there are substantial reasons why the integration of TWX and Telex would be in the public interest. From the users viewpoint an important consideration is to overcome the isolation of some 3000 TWX subscribers from the mixed business Telex community of 20,000 subscribers. In addition TWX subscribers by joining Telex would have access to local telegraph offices and to TelTex service to complement their record handling capability. There are however more compelling reasons to integrate these two networks or more specifically to absorb TWX service into the Telex network.

With the acquisition of TWX by Western Union in the USA, Canadian Telex will also access American TWX. Therefore, from

the traffic and community of interest standpoint it is clear that TWX subscribers should be added to Telex.

TWX service as presently provided does not have its own long distance switching plant. It uses the same facilities as the long distance telephone service. Even so charges for TWX service are lower than long distance telephone charges* and are not subject to a two/three minute minimum charge. This clearly suggests that TWX services are subsidized by public telephone users.

On the other hand, Telex service uses telegraph long-line plant which occupies just enough frequency spectrum to render reliable service dictated by the speed desired. If Telex were not a viable system it could not mask its deficits with profits derived from captive customers using the same network.

Furthermore, while TWX operating at 110 baud requires a full telephone channel (4000 Hz), 110 baud Telex uses 340 Hz. This bandwidth wastage of frequency space is reason enough for transferring TWX service to a network specifically designed for the teleprinter speeds required.

It is important that the legislators insure that the portion of the spectrum assigned to public long distance telephone system is not wasted. To this end we recommend that the public long distance plant be used only at speeds exceeding 600 bauds. In addition to avoid cross-subsidization and to simplify regulation, any digital service offered by the telephone companies over their public long distance network should be subject to the same tariff charges and rules as applicable to long distance telephone service.

* TCTS state this to be true only in some cases.

In our view there are overwhelming advantages in favor of transferring TWX subscribers to the Telex community operated by CN-CP Telecommunications. The most important, from the user standpoint, is the availability of a completely integrated record service paralleling the voice service offered by the telephone companies.

We believe it to be in the national interest to protect the telegram service in Canada. Many users cannot afford other more expensive substitutes and for many purposes the telegram is the most satisfactory way for these users to convey records from one point to another. To automate record handling and offer an alternative to telegram service, CN-CP introduced Telex in 1957, a form of do-it-yourself public message service. This meant that large telegram customers adopted Telex which greatly reduced the volume of public telegrams without a corresponding reduction in operating costs. However, additional Telex revenues and an improvement in service were sufficient incentive to continue our efforts to convert telegram users to Telex service. TWX came into being six years after Telex and contributed further to the erosion of Public Telegram volumes. But, diversion of customers from Public Telegram to TWX has meant greater deficits in the provision of telegram service without compensating revenues. An integrated record system, provided by CN-CP would correct this situation and strengthen the public telegram service.

The foregoing clearly shows that the public interest will best be served by integrating TWX and Telex under one administration. It is also clear that this administration should be CN-CP Telecommunications.

Private Line Services - For CN-CP to achieve the goal of effective competition in the Telecommunications industry in Canada, two primary conditions regarding interconnection with the telephone system's plant and service must obtain:-

1) CN-CP must have access to dedicated local distribution facilities (loops) as long as they are provided exclusively by the telephone companies.

2) CN-CP must have access to public switched telephone networks for local extension of their private line services.

The converse is equally applicable for the telephone system, given that CN-CP has a monopolistic public record system. The telephone system must have access to the public record system for local extension of their private line record services.

At this time the telephone system has developed a vast system of distribution facilities (loops) for local extension of its public telephone service. Since these facilities can be used and are used for local distribution of many other Telecommunications services, it is in the public interest that unecomomic duplication of these facilities be avoided. CN-CP has recognized this public interest by adopting a policy of acquiring local loops from the telephone system rather than constructing their own facilities where adequate transmission capabilities exist.

Since all Telecommunications Services originate and terminate on customers premises, it is axiomatic that as long as local distribution facilities are provided by a single carrier, any competing carrier must have the right of access to these facilities at reasonable

rates. The right of access should be guaranteed by law.

In addition if a carrier providing a public switched network permits interconnection of any of its private line services to any part of such networks, a similar right of interconnection for the other supplier of private line services must be required to afford equal competitive opportunities to both Carriers in the private line service area.

Specifically, to afford effective competitive opportunities for private-line voice services CN-CP must have the right of access to local telephone exchange facilities. Telephone companies' private line voice services may interconnect with the local public telephone network at any customer terminal. As this additional service is denied CN-CP customers, the Telephone companies have an unwarranted advantage. The absence of such access puts CN-CP on a wholly unequal basis and renders competition between the two Carriers a mere illusion.

To avoid misunderstanding, we do not seek nor envisage entry into the public telephone service market, but rather urge the introduction of effective competition for private line services. We acknowledge and respect the need, in the interest of the public to preserve the integrity, reliability and viability of the public telephone system. Specifically we seek the right to extend our private line services from a subscribers terminal into the local (metropolitan area) switched telephone network on the same basis that the telephone system now permits extension of their private line services.

This is of particular significance today as many users of Telecommunications Services contract for service of various types, in large quantities, as a total package. The ability to use total service capability is a prerequisite to effective competition. The inability of CN-CP to provide private line voice services along with record services on an equitable basis with the telephone companies automatically stifles effective competition in a substantial segment of the market which should be truly competitive. With the expanding demand for bulk telecommunication services, it is essential that CN-CP be in a position to capture its fair share of this market and achieve economies of scale available to the telephone system. Failure to do so will inevitably reflect on its ability to competitively price its private line and exclusive services.

Opposing Arguments - The traditional arguments one encounters against interconnection center on interference with average cost pricing and "cream skimming". In respect of the average cost pricing argument, it is often stated that provision of local and long distance telephone services have been intermeshed and their pricing designed to average out inordinate disparities with the result of more people having more reasonable priced services. It is probably true that revenues from long distance services subsidize local service, to a degree, resulting in lower rates for local users and higher rates for long distance users. Interconnection will introduce competition in the over-priced long distance monopoly.

The argument that interconnection will give rise to "cream skimming" is not without some validity if traditional communications services pricing policies based on system-wide costs, continue to prevail. However, the pricing of communication's services may, and perhaps ought to be, based on specific costs of serving specific markets. If competition is to yield improved efficiency in communications supply, which we contend, then there is cause to question the traditional policies and consider the alternative that pricing should be related to the markets involved.

We contend that the market for private line telephone service need not be integrated economically with that for public telephone service and that rates established for such services should be based on costs and demand. This view is not inconsistent with the position that the integrity, reliability and viability of the public telephone systems should be preserved. Likewise, it is consistent with the situation proposed for a public record system wherein similar arguments with regard to cream skimming can be advanced.

The degree to which prices may rise for local telephone service, the basic criticism against interconnection, is difficult to judge because no data are available on the extent to which cost averaging takes place. Nevertheless it is inconceivable that local rates for public telephone service would be substantially affected by increased competition for private line services in view of the relative sizes of public and private telephone markets. As shown in the report of the "Seven Way Cost Study" in the United States, (Page 84 herein)

the ratio of earnings from these two markets was approximately 25:1 in 1963-4 favoring the public telephone service. Granting subsequent changes in these figures from revisions in tariff structures and changes in demand, it is considered that a similar order of difference applies today in Canada.

In conclusion we believe that the public interest will be served by CN-CP Telecommunications having the opportunity to compete for new business and a fair share of future business growth. Continuing success for both CN-CP Telecommunications and the telephone companies would confirm our belief that Canadian users not only want the ability to choose between suppliers but seek the benefits accruing from competition.

PART VIII TCTS CARRIER TO CARRIER INTERCONNECTION PAPER

The following is a verbation reproduction of part of the TCTS paper with added paragraph numbering. The remaining part on TWX-Telex has already been introduced in Part V and studied in Part VI.

8.1 Introduction

This submission on behalf of the Trans-Canada Telephone System deals with the problems which would arise if interconnection of the service offerings of competing common carriers became general as opposed to the leasing of facilities between such carriers.

The term "interconnection", in this context, implies joint provision of one "Service" for the user, or users, of such "Service".

"Service" falls into two broad basic classes:

8.1.1 "General Public Telecommunications Service" is one to which any member of the general public can gain access to any subscriber of a telecommunications network standard schedule of rates.

8.1.2* "Private Line Service" is designed to meet the private needs of specific customers for communication between prescribed points and to which only they shall have access.

* See note page 98

While most of the current telecommunications service offerings may be considered as either "Public Telecommunications Service" or "Private Line Service", some service offerings may not seem to fit either definition precisely, for one or more reasons. For example: tie trunks between Private Branch Exchanges, and Foreign Exchange Services, may appear to have "private line" characteristics, but, in actual use they are part of general public telecommunications service.

It should be noted that the term, "Private Line" has been used in the industry for a great many years. It probably originated as the name for a pair of wires with a magneto telephone at each end. Use of the term has evolved, however, to describe a number of entirely different services. For example: Basic residence telephone service is provided by individual line, two-party line or multi-party line (usually in rural areas). The vast majority of users call their individual line a "private line."

Teletypewriter service that is point-to-point, or multi-point, as opposed to switched service (Telex and TWX) is "Private (Wire) Line Teletype."

"General Public Telecommunication Service", insofar as the switched telephone network is concerned, has, over the years, accommodated progressively more special telecommunication requirements or in the broad sense, "Data." Early examples included transmission of photographs by the so-called "Telephotograph" technique, and dial-up

access to recording devices that report, for example, water levels in a storage reservoir, time of day, weather forecasts, etc. In recent years, with the development of a wide variety of terminal devices and data interfaces, the switched telephone network serves both digital and analogue data applications which range for example, from the transmission of electro-cardiograph tracings, facsimile, to handwriting via "Electro-writers". These are, in effect, alternate uses of the network's capability.

As additional requirements are identified, the telephone network is adapted to accommodate current and future needs. This involves switching as well as transmission capability.

By utilitizing the basic components of the network - such as rights-of-way, supporting structures, buildings, power, etc. - plus available design, installation and maintenance capability, the result has been that expanding telecommunication requirements are accommodated with efficient use of resources and technological advances.

An obvious example is the manner in which network television facilities have been provided in Canada.

The optimum situation in any telecommunications "network" is to have responsibility and accountability for the "network" vested in a single entity.* The Trans-Canada Telephone System, with its common standards of service, design and operating parameters, closely approaches this ideal situation.

* See also Study 8(b)(i)

8.2 Interconnection

Let us now examine "interconnection" of the services of competing common carriers, and try to identify the extent to which such services are now "interconnected", and the need, if any, for such interconnection.

Basically, "systems" are designed to provide optimum performance, end-to-end. To date, in Canada, there are comparatively few cases where "systems" are interconnected.

Where such cases do exist, the circumstances are, or were, quite different from the requirements of the vast majority of users of telecommunications services. Two examples of carrier to carrier interconnection are: -

8.3 Telecommunications For Defence

In some areas of telecommunications required for the defence of Canada, the common carriers supply a variety of facilities which, in addition to providing route diversity, are, in some instances, interconnected parts of an overall "system". An example is the Canadian Forces Switched Network (CFSN). The telephone industry provides the switchers, but not all of the trunks and access lines.

8.4 Radio and Television

The common carriers are involved in four main contracts for the provision of the transmission facilities that comprise the existing Canadian broadcasting networks - CBC Radio, CBC Television (English & French), and CTV Network Ltd.

Interconnection for the more sophisticated quality service that television demands is rare indeed. Within the industry, such interconnections are considered undesirable because the involved common carriers engineer and design to somewhat different specifications, and each such interconnection requires that both the audio and video channels be brought down to baseband frequency, with some degradation occurring in both signals. On faults of course, there is still the need to ascertain which common carrier is the contributor, so that service can be maintained.

The telephone industry holds the prime contract for the provision of the CBC Radio Service to some 340 stations, over 25,000 miles of transmission lines. Because of the scope of this service, covering as it does a number of remote communities, many segments of this network service have been provided under sub-contract by other common carriers, principally CN/CP Telecommunications. The interconnection of these facilities, normally a 5KHz program line, between one carrier and another, does not present any appreciable problems - other than the sometimes contentious one of tracing faults so that the responsibility for the trouble can be clearly identified.

Because of the special nature of these facilities that are required by the broadcast industry, and the substantial investments involved on the part of the common carriers, the manner in which facilities have been made available appears to us to have been a reasonable approach.

There are a limited number of other situations in which the facilities of the common carriers are interconnected in a working system. These usually involve special circumstances applying at the

time and, generally, meet requirements in the area of defence or emergency use in the interest of public safety.

We are now going to discuss some services where there is no carrier to carrier interconnection: -

8.5 TWX and Telex (see PART V)

8.6 Private Line - Voice

* In the case of Private Line - Voice, the user has a choice of supplier, although this may be limited by the availability of facilities between some service locations.

The TCTS Companies believe that lines of this type are primarily bulk-rate voice message and, as such, should continue to be supplied competitively, with no connection to the general switched network or interconnection between competing carriers.

8.7 Private (Wire) Line Teletype

Private Line Teletype is provided competitively by the common carriers in most parts of Canada.

There appears to be no evidence to suggest that interconnection of this service would benefit the customer of the common carriers, or that lack of interconnection has impaired overall development.

We recommend that the Private (Wire) Line Teletype Services of the competing carriers should not be interconnected.

* Private Line - Voice is considered as a public telephone service by the Telephone Companies and regulatory bodies in Nova Scotia and Prince Edward Island. As such it does not qualify under the definition of private services in those areas.

8.8 Broadband Exchange Service and Multicom

These competitive switched services are designed to serve data transmission requirements in medium and higher speed applications. Their basic designs are for end-to-end system operation, and, as designed, they are incompatible with respect to mix, or interconnection.

Both services differ from the switched telephone network in that they employ 4-wire switching, end-to-end, rather than 2-wire, and meet more stringent performance characteristics required for data transmission.

Both have voice capability, a useful feature for setting up and supervising data system transmissions. Because of their voice capability there is no effective way to restrict these services to the transmission of data only.

To the extent that they are used as a substitute for public message voice, such use erodes growth of public message voice service by "cream skimming" the higher density routes (and not serving) the less attractive routes) and can only work to the detriment of the public telephone network and its users.

The problems associated with "cream skimming" and discriminatory pricing are discussed in detail in Telecommission Study 7(ab).

Consequently, neither MULTICOM nor BROADBAND EXCHANGE SERVICE should be interconnected with the public message voice network.

As to interconnection, one service with the other, while their system designs are incompatible for end-to-end operation, it is technically feasible to make them work together but the cost would be substantial.

At this stage of development in the volume of data being transmitted in Canada, there appears to be merit in having competitive service offerings.

8.9 General

The Trans-Canada Telephone System makes its extensive local distribution facilities available to CN/CP, to facilitate the serving of CN/CP customers. In effect, the use of this valuable asset is shared, but the investment risk is not shared.

In addition, the widespread inter-city facilities of the telephone industry may be used by CN/CP to "piece out" their customer services, as required. The arrangement is a reciprocal one, although the "piece outs" supplied by the telephone industry tend to be on lower density, higher cost routes.

These arrangements reduce unnecessary duplication of basic telecommunication structures.

8.10 Conclusion

In general, it is the opinion of the Trans-Canada Telephone System members that interconnection of competing common carrier service offerings is not warranted, either by benefits to the vast majority of telecommunications users, or to the common carriers.

Any unusual situations that may develop, where interconnection might appear to be appropriate in the public interest, should be examined, considered and resolved by the competing common carriers, jointly, in a mutually responsible manner.

PART IX COMMENTS ON INTERCONNECTION PAPERS

9.1 General

The total satisfaction with the status quo as expressed by the TCTS position paper, suggests a position which is remarkably static considering the driving problems behind the strong controversies in telecommunications that exist just across the international border. Perhaps the Canadian government is just a little behind the FCC in opening new doors. Certainly the CN/CP Telecommunications paper takes this view, for after a preamble advising the continued acceptance of the general principle of competition within the industry, it vigorously supports new services concepts based upon a new monopoly form, and upon opening up of interconnection practices. On the other hand there are those who believe that the doors should remain locked.* Some details of each of the papers can stand elaboration for clarification or to bring out the less evident inter-relationships.

9.2 CN/CP Tel Paper (PART VII)

Ref Section 7.3, citation of the report on "Airline Competition in Canada" as an indicator of a direction for Canadian telecommunications is noted. There is a multitude of differences between the specifics of the two situations. The major difference is the relative stability of the telecommunications networks compared to aircraft routes.

In the last paragraph there are two important themes that are undeveloped. First, "freedom of unrestricted entry" currently amounts

* See President's Task Force on Communications, Final Report, Dissent by James D. O'Connell.

in the U.S. (and could here in Canada) to an out and out battle between the telephone system and entirely new companies such as DATRAN and MCI (see also Part IV) for the possession of the Data networks in the U.S. Now CN/CP Tel are submitting the possibility of starting a Canadian battle, restricted to two factions. TCTS will counter, with little prompting, that Canada cannot afford to experiment with federal policies which could lead to any sort of conflict. Secondly, note the phrase "in the provision of particular Telecommunications Services, etc...". CN/CP Tel are proposing instead it would seem, to obtain a particular share (i.e. the public segment of all non-voice services below 600 baud) of many services.

Supplementary to 7.4(b)(c) one may add by way of definition, line switched services might be defined as those in which after the initial connection has been made there is no further delay in transmittal of the message (except for propagation time which is not perceptible to the receiver). Message switched services with store and forward techniques can introduce controlled delays for many purposes. They involve storage media in the switching system.

It is essential to recognize that this paper uses the term "Message-Record" in the modern sense, i.e., to mean any recorded form of message be it a paper printout and/or a store in a computer. Therefore, the monopoly under discussion includes all forms of non-voice communications in the public switched network sense, except for the 600 baud rate limitation. Specifically, this blankets the low speed public switched Data transmission field which has been emphasized in Part VIII by TCTS, as being essential to a successful build-up of their Data services. Owing to the versatility of computers and

their terminals there is no practicable way of policing a split between messages which are computer oriented and those which are not. A computer terminal will printout an ordinary conversation, and a computer can be used to switch between various terminals on its network. If there has to be a split between the services offered by the competing carriers a practical (technically) method is to set a baud rate as the dividing line. This is the method proposed for the division of services between W.U. and A.T.&T. as noted earlier, although the rate selected in that case is to be 300 baud. The selection of 600 baud by CN/CP Tel has merit.

Note, however, that the recommendation that "CN/CP assume exclusive responsibility for store and forward switching techniques in the provision of public (record) services" would eliminate competition in this message switching field unless the phrase "up to and including 600 baud" is appended thereto.

Section 7.5 continues to expound on the dividing lines between monopoly and non-monopoly type services. The argument is advanced that a distinction can be made on the basis of the smaller number of points for connection.* A monopoly also might equally well be accorded to either of two groups, one of which was much smaller than the other. Even classes of service become very hard to separate when computers are employed and hence the final resort to speed as the only 'break' point in controlling a telecommunications monopoly.

* top of page 84.

"Interconnection will introduce competition in the over-priced long distance monopoly" is a statement, which like an iceberg, conceals nine-tenths of its body. In comparing long distance rates between the two carriers one must first of all compare systems. It is understood that the concentration of the CN/CP Tel capital investment is in main trunk routes, whereas TCTS have in addition a very large investment in feeder trunks and particularly in toll exchange (switching facilities). TCTS argue that CN/CP Tel through 'piece-out' agreements have full access to the TCTS feeder trunk* and exchange plant without capital risk. They also argue that the cost effectiveness of the larger system is inherently less than the particular services owned by CN/CP.

9.3 Comments on Part VIII TCTS Paper

The reference to abandonment of the investment of equipment in use once service was discontinued, voices a serious point or not, depending upon the case being considered. Abandonment of the Telex investment would be serious, whereas it would not be so for TWX.

The discussion on private-line voice is so brief that the reader is left wondering just what element of competition is left in this region. The position taken by the two Maritime Provinces is that there is, and should be, none. CN/CP Tel say that without access to the public switched network a competitor has little chance.

* According to CN/CP Tel this is reciprocal in full.

The second paragraph in 8.1 and the first in 8.5 both make statements implying that users of low speed data services become adapted to a particular transmission system such that it becomes a wasteful expense to change. Exception can be taken to this point, which is not a very strong one. One cannot discount, however, the value of the initial sale to a customer, who providing he is satisfied, usually becomes "your man".

In general one must accept the fact (which has been ably argued by both parties) telecommunications services are most economically designed and built as systems. In a few years time, as these networks for Record, Message and Data services grow, interconnection costs (see 8.8, page 102) could be prohibitive. Segments of the economy would be artifically separated by a communications blockage which could only restrict growth of commercial, financial and industrial institutions and services. We all know that 'static' does not apply to our society. The competing Broadband and Multicom services will continue to grow. TCTS in other papers submitted to the Telecommission, support a one-system concept, and also other devices such as vertical integration to support system economies of scale, etc., but now in the case of new non-voice services, endorses limited competition, and also the fabrication of separate physical plants.

9.4 Conclusion

These comments have been designed to show two things. First that if the subjects were all treated in depth it would be seen that for every argument of the one party there is a counter argument at the command of the other. In such a situation decisions almost certainly must be arbitrary. Secondly, is 'Interconnection' the major issue? In some cases where a considerable amount of plant has been invested in two systems it may be. It is believed that from technical and operational considerations interconnection in general would introduce many costly new problems. It is just this that points to the old adage that 'prevention is better than cure' and therefore it is time for the Government to pause to consider whether the two-system concept is to be endorsed for those new services such as Multicom and Broadband (or say Data Services in general) where the specific plant investment to date is not such as to inhibit decisions for the best interest of the country.

Lastly, a third point must be raised and this is that in these papers there is no insight given into the future development of the technologies under discussion. It is known now for example that neither Broadband nor Multicom as a system meets the standards of switching performance which will be required for mass Data transmission. If other newer systems are to appear in this decade of what use is it to make recommendations which may take years to effect, and which will be concerned with only present day techniques? In PART X an attempt is made to widen the perspective on these problems by constructing a timetable for communications technology.

PART X WHAT WOULD BE BEST IN THE PUBLIC INTEREST

10.1 Western World Developments

We have seen what has happened in the U.S. where studies instituted by the U.S. government, on both economic and technical problems in telecommunications, have been in progress since 1965. These have resulted in a decision to decree* that there will be at least one Integrated-Message-Record-(Data) transmission system in the U.S. Furthermore this system will be outside of the telephone network. It will be technically and economically controlled by a single organization.

It will be useful to complete the overview of what is happening elsewhere in the Western World, namely in the U.K., France and West Germany. Canada must seriously consider developments in all of these countries in order to keep in step with the world telecommunications environment.

10.1.1 United Kingdom (UK) - In the UK, two institutions are actively studying and experimenting with Data transmission problems. These are, the National Physical Laboratory, and the Post Office, the latter now being a Crown corporation. A market study for transmission to effect a 15 year forecast was instituted by the Post Office in 1968. Twenty-five sectors of industry were studied as well as of the local and national governments. The consensus was that the 'seventies' would see a high growth rate in demand for data services e.g. by 1978/9 (allowing the usual provisions for error in such figures), 234,000 subscriber terminals are forecast. It was also concluded

* Not finalized as of Aug. 10/70. Re Data see 4.5.6

that most outstation terminals would have a data bit rate up to 10-24 Kb/s. (This is the hi-speed data range.) The National Physical Laboratory has an engineering model of a very advanced data transmission system under test now. The Post Office has active plans to install trial Message-Record-Data systems before 1975. Such systems will be all digital and will not attempt to make use of the telephone network except possibly for subscriber loops where special metallic pairs would be used. The Post Office policy will be to discourage inter-working of the Data and telephone networks until the distant future when hopefully there will be a single network containing telephony and non-telephony signals. The necessity for interfacing on a limited scale, at all times, is however recognized. It is envisaged that the new Data network would carry future expansion of the Telex network. Thus the U.K., as is the U.S., is opting for a separate Telex-Data network. In the U.K. of course all service is under the control of the Post Office. It is therefore easy to commit to a single system only, whereas the U.S. due to various pressures, has additionally opened the door to a proliferation of Data only services.

0.1.2 France - The situation in France parallels but lags that in the U.K. Trial integrated systems between selected cities are in the works. A Common Market group study indicates no likelihood of wide scale integrated digital systems before 1990. It also sees the end of the electro-mechanical, analogue telephone era as the first decade of the next century. On the other hand, growth rate of Data services currently is 100% per annum, a rate which is bound to force many changes. Telex growth rate is 15% annually. Separate digital and telephone

systems are foreseen in this century as a matter of economic and technical necessity because the demand for telephones is so urgent that a delay in expansion of voice services due to introduction of digital technology cannot be tolerated.

10.1.3 West Germany - This nation has a different situation. The German Post Office, using the Siemens organization, is moving aggressively. There is a firm commitment to have an Integrated Message-Record-Data System operational by 1979 between most of the major cities. Trial systems will start in two years. Siemens have in the works production prototypes of a new Electronic Digital Switch (EDS) which is to be the backbone of the new system. (Note: Western Union have ordered an EDS system for earliest possible delivery). The new system will be additional to the telephone network. The Germans see little likelihood of matching with the telephone network before 1985-90.

In summary then, Canada's western*neighbouring governments have completed studies, conducted experiments and have advanced operational plans during the four or five years preceding 1970, and in a manner unmatched by Canadian government departments. All of the neighbouring governments have made commitments to establish and make operational in the 1970s if possible, new systems designed to provide facilities for the advancement of computer technology in their economies.

10.2 Communications Technology Timetable

To further implement the overview, a chart (Fig. 6)

* What of Japan? No first hand information is available.

COMMUNICATIONS TECHNOLOGY

TIME CHART

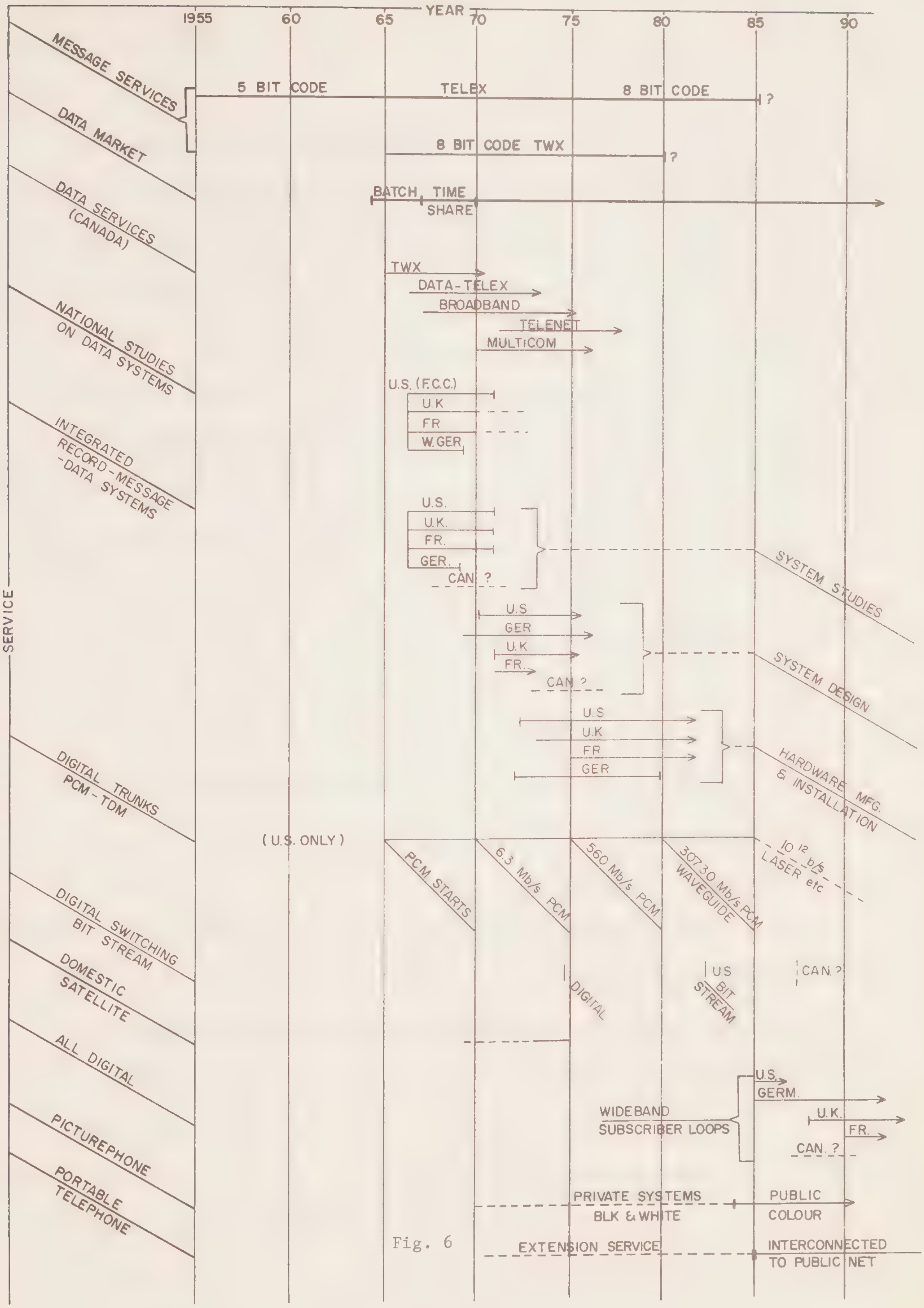


Fig. 6

has been prepared to illustrate this development of all of the new communications services and especially those under discussion in this text. The purpose is to show that all services from Telex to videophone will be involved in the evolution of digital transmission systems, and to suggest therefore that decisions made currently for any particular service should be made with long range developments in mind. Of course such a chart reflects opinions from various authorities, which vary +50% to -20% with regard to increments on the time scale. However it is necessary to recognize that the events shown are not only possible, but also probable. It is interesting to note that American observers will say that the European states* are ten years behind the U.S. and that Canada is five years behind. These remarks are probably true with regard to telephone services in Europe, but there is a definite possibility now that some overseas countries will leap-frog their telephone problems, into equivalence with U.S. technology in data transmission.

Before scanning the chart, attention of the reader is drawn to a few of the elements which will characterize the ultimate telecommunications system required for data, and also for voice, if the two are ever to be compatible. These elements are:

Trunks	code speeds (bits/sec) pulse code modulation (PCM) for digital trunks
Switches	digital switching digital bit stream switching (PCM-TDM)
Subscriber loops	wide bandwidth

* Essentially, west of the "Iron Curtain"

Starting at the top of the chart it is seen that in Canada, Telex is an early system. It has developed using a 5 bit code in a d.c. mode which is too limited for Data services. A suggested code transformation is indicated in the seventies. TWX has always used an 8 bit code. (Actually, at least 8 bits will be required for data systems and codes using 11 bits at least may be predicted to emerge.) It would be a reasonable guess to say that each system will be sufficiently transformed by 1980-5 to have lost its original name and identity because of development of digital technology. The first two lines on the chart represent teletype message-record service for the first half of the period with introduction and build-up of the low speed Data function for the second half.

Only Batch processing and Time-Sharing are highlighted in the Data Market. From 1970 onwards the market presumably will build on these basic concepts to embrace a multiplicity of services. (This line is 'out of place' as it does not refer to an element of telecommunications, but it serves to pinpoint the Data services.) TWX as we have seen is a low speed Data service; Data-Telex offers low-medium speeds, and Multicom and Broadband offer a wide range up to 50 kb/s, which is the highest subscriber terminal speed level we can expect for general use for many years, although direct computer to computer connections will have to operate at much higher speeds eventually. Multicom uses modified E5 crossbars and special line facilities. It is Data transmission in the telephone image and will disappear with the advent of a true digital system. Its usefulness will start to decline rapidly by 1977-79 if Canada moves vigorously into digital technology.

TELENET is a logical extension of message-record systems to employ computer technology to improve system efficiencies and to add to services offered to subscribers, as we have seen in 2.5.

FDM services are expected to peak in the late seventies when minimum cost hardware using LSI* will be available. During the seventies FDM-PCM combinations will appear. PCM which is a basic technique for digital transmission, is advancing rapidly in trunk route service. The measure of its advancement is the bit rate. Dates shown should be retarded 5 years for Canada. Rates in the thousands of megabits will be required before digital systems will become universal. 10^{12} b/s, the maximum rate shown, is generally accepted as possible although not before 1985 even in the U.S. ** Concurrently with PCM, digital switching will develop. Such switches will be all electronic but must not be confused with the new electronic switches now being brought forward by the telephone companies. These, although computer controlled, are designed to service voice systems. The Siemens EDS would appear to be a first generation digital switch. It has no multiplexing features but operates in a circuit switching mode to exchange digital signals between subscriber lines. This switch is a forerunner of the techniques required for simultaneous switching and multiplexing (PCM-TDM). Predictions on this latter subject are unreliable. It depends upon whether one is

*   LSI - Large Scale Integrated circuits

** Will depend upon Laser systems (or equivalent)

discussing what could be done or what will be done. To establish a universal digital system it will also be necessary to improve the subscriber loops from ordinary pairs of wires to balanced four wire and/or coax. This will be paced by the expansion rate of new voice plant and replacement of old. If the predicted growth rate of 12-15% holds, then in 15 years more new plant than old should exist, and this is marked as the start of "all digital services" in the U.S., assuming that country still to be the world leader.

Public switched color videophone would be practical over a digital network and until such a network with its megabit technology is available, we are inclined to link videophone to private systems only.

Portable telephone is expected to develop for some years as an extension of a subscribers local. A truly portable dial-in service being part of the public network awaits further technology developments.

Domestic satellite services commencing in the mid-seventies will make a contribution to the technology. Satellite transmission is favorable to digital techniques because of the relative freedom from burst noise interference common to ground communications systems. The nearly white noise background in satellite channels has led to important advances in digital channel coding techniques. Transmission of digitized video may be done advantageously, but in the case of Data, propagation time restricts answerback checking techniques.

The foregoing chronology of the advancement of the art of telecommunications is a consensus of opinion, with a preponderance of telephone industry inputs. Executives within the industry will confidently confirm that 1985 is an earliest practical date for widespread use of digital systems. The system inertia generated by telephone plant that was built to last, and the continuing demand for new voice services, both are pace setting factors which lend credence to the idea that changes will be long in coming. At this point then our forecast appears to be safe.

However, consider the following announcement in an industry wide press release of August 10, 1970:

> "A $7,000,000 system integration study program to ensure the compatibility of all elements in the (proposed) nation wide common carrier Data transmission network was launched last week by the Data Transmission Co-Datran"

Further details reveal that the studies will cover:

transcontinental microwave trunk system
computer controlled switching centers
local distribution systems

also the new techniques such as:

digital modulators for use with the trunking system
TDM (Time Division Multiplex)

and a test system.

Is this new system to be used in the second decade ahead? Not at all, millions of dollars are being gambled now by DATRAN, that starting at once they can have a large scale digital transmission system operating in this decade. The question is, can they do it?

10.3 The CN/CP Tel and TCTS Organizations

Before any final recommendations with regard to TWX-Telex and/or Data transmission in Canada can be made, certain basic assumptions as to the future status of the two principals must be stated. This is necessary because of the natures of the two organizations.

The CN/CP Tel organization operates on the basis of a signed agreement originating from the terms in certain sections of the Railway Act. This is a long term agreement and is one of long standing also. Nevertheless one must question the longevity of the agreement because it marries a crown corporation (CNR) which is dedicated to the public service, to a corporate giant (CPR) which is dedicated to the profit motive. For the association to continue it will be necessary for the Government to support its mandate to the CNR to stay in the communications field and for the CPR to continue to make a satisfactory profit. Neither of these conditions can be taken for granted.

The fact is, that Canada is standing on the threshold of a decade of heavy expenditures for Message-Record and Data transmission, involving multi-millions and perhaps billions of dollars for new plant and equipment in addition to the expansion plant which will be required for voice services. If the CN/CP Tel group wishes to commit to the new services, then the Government will

have to decide how far it can go in providing financial support, in competition with the telephone monopoly group, (unless a non-competitive situation is developed for Data transmission). Furthermore if the new plant is to come under government regulation, as is likely, then the allowable profit must be such as to satisfy the CPR in order for the alliance to hold.

On the other hand the TCTS is a loose organization of telephone companies which has no charter, and no legal identity. The rules for membership are ill defined so that it is impossible to predict TCTS growth. The need for a change is real and a restructure is predictable although the timing may not be.

10.4 Considerations

10.4.1 Introduction - In this paper interconnection of TWX-Telex has been related to Data transmission but not to voice. The papers on Interconnection deal with all three as special cases of a single problem. An alternate view is that they are to such a limited extent that separate solutions can be found. Therefore at the risk of being accused of oversimplification by separating voice from the others the latter will be dealt with first.

10.4.2 Voice-Interconnection - The principal reason for the demand by CN/CP Tel for voice interconnection through the switched public network is that this would greatly increase their competitive position for the leasing of private circuits for voice. Consideration must be given also to the argument advanced by the CN/CP Tel to the effect that

monopoly carries its own obligations and one of these is that the switched network services, which have been developed under the umbrella of monopoly, must be accessible to any buyer on favourable terms, even to a competitor. Two provinces, (ref page 101) may have set a legal precedent for the argument that once voice interconnection is established the resulting system is no longer private but public and therefore enters the general monopoly. Judicial consideration would probably lead to a solution of this problem.

10.4.3 Interconnection TWX-Telex - Interconnection, can be defined to be limited to interfacing of technology and services and not of management or corporate organizations. Interconnection pre-supposes that two technical systems exist and will continue to expand on their separate paths and with them the services and costs for interconnection will also increase.

We have seen that the ratio of Telex to TWX used for Message-Record services is 5:1 whereas in the U.S.A. it is closer to 1:1 and consequently there is much less possible business dislocation in Canada as a result. Noting also that this ratio is not likely to worsen in Canada as the TWX system is expected to develop as a Data transmission service, then it can be said that there is no pressure for interconnection of the two systems in Canada. Immediate needs can easily be met as TCTS have suggested by subscribers renting a second terminal. Lastly, all of the arguments against interconnection advanced by both competitors and as noted from the U.S. studies seem to us to be valid.

10.4.4 Integration of Services - Integration we define to include complete unification with one technical control and at least a unified managerial

structure. It is only through integration that the following benefits can be obtained

1. Maximum Canadian commercial and sociological development. A dual, interconnected system restricts communications both within the country and with neighbouring nations.
2. Most economical integration with services in neighbouring countries because of unified long range planning with them.
3. Add to these weight of the arguments advanced by CN/CP Tel (7.4) which seem to be reasonable and cogent.

These arguments lead to the conclusion that some form of integrated service for Canada must be considered. If the earlier prognosis on developments of technology is at all correct, then Data transmission will be the central issue for integration.

The CN/CP Tel submission for a limited monopoly below 600 baud is not related to any time frame nor is any hint given as to how the resulting integrated system could or would expand ultimately to encompass the range of Data transmission foreseeable as a requirement in the next two decades. Thus there is no measure of the probable life of the proposed system. At the same time it is proposed that the private service Data market above 600 baud be developed competitively. Already between the Broadband Interchange and the Multicom system we have competing wide-range Data services not necessarily committed to identical technology. This means that in a matter of a few years a major interconnection problem could develop as the computing machinery of the business world will become less and less tolerant to incompatibilities between competing systems.

There is no way in which two mutually exclusive Data systems can be developed in Canada without giving rise within this decade to a serious interconnection problem as well as to duplications in plant and other costs. Also, it has not been established to what degree the CN/CP monopoly could be effective since it excludes private services which seems to offer a generous loophole.

10.4.5 Conclusion - We have shown that governments of our Western neighbours have made important decisions with regard to integration of services, and to data transmission technology. In similar areas Canada stands as yet undecided and uncommitted. At the least, more study and research into data transmission technology is indicated. This would require more active participation in the CCITT backed by more Government and industry research. Additionally, it is clear that it would be advantageous to Canada and to the U.S. if long term understandings with the FCC and also W.U. were entered into. These will be required for the coordinated development of Record-Message, Data services on this continent. Finally, the development of digital telecommunication technology for the advancement of data services in Canada in an efficient and logical manner, is a task of great magnitude and complexity. Therefore it is to be expected that the Government will assume a responsible role in this field in order to protect the public interest.

APPENDIX A

BLOCK DIAGRAMS FOR THE TELEX NETWORK

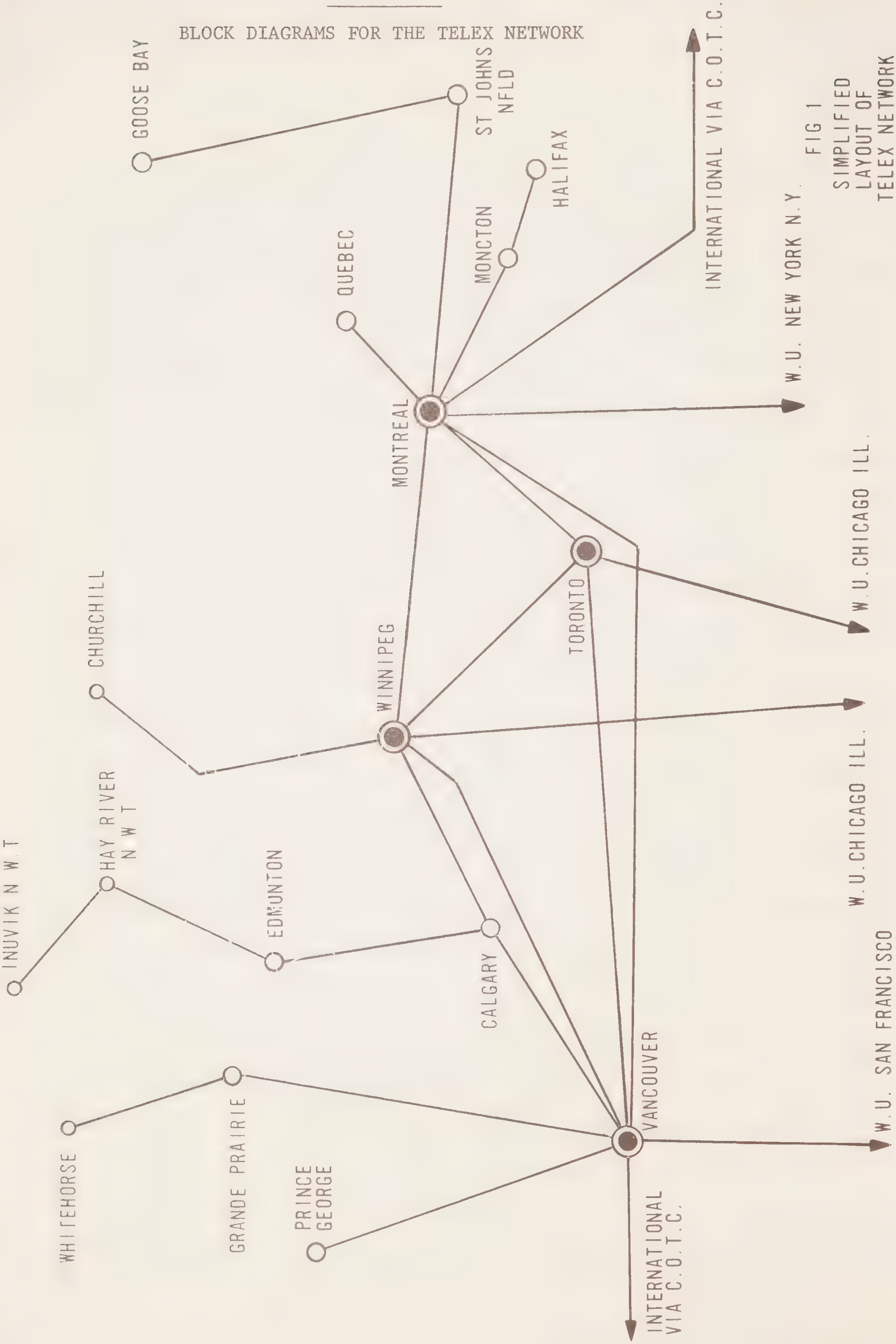


FIG 1
SIMPLIFIED LAYOUT OF TELEX NETWORK

LOCAL CALLS

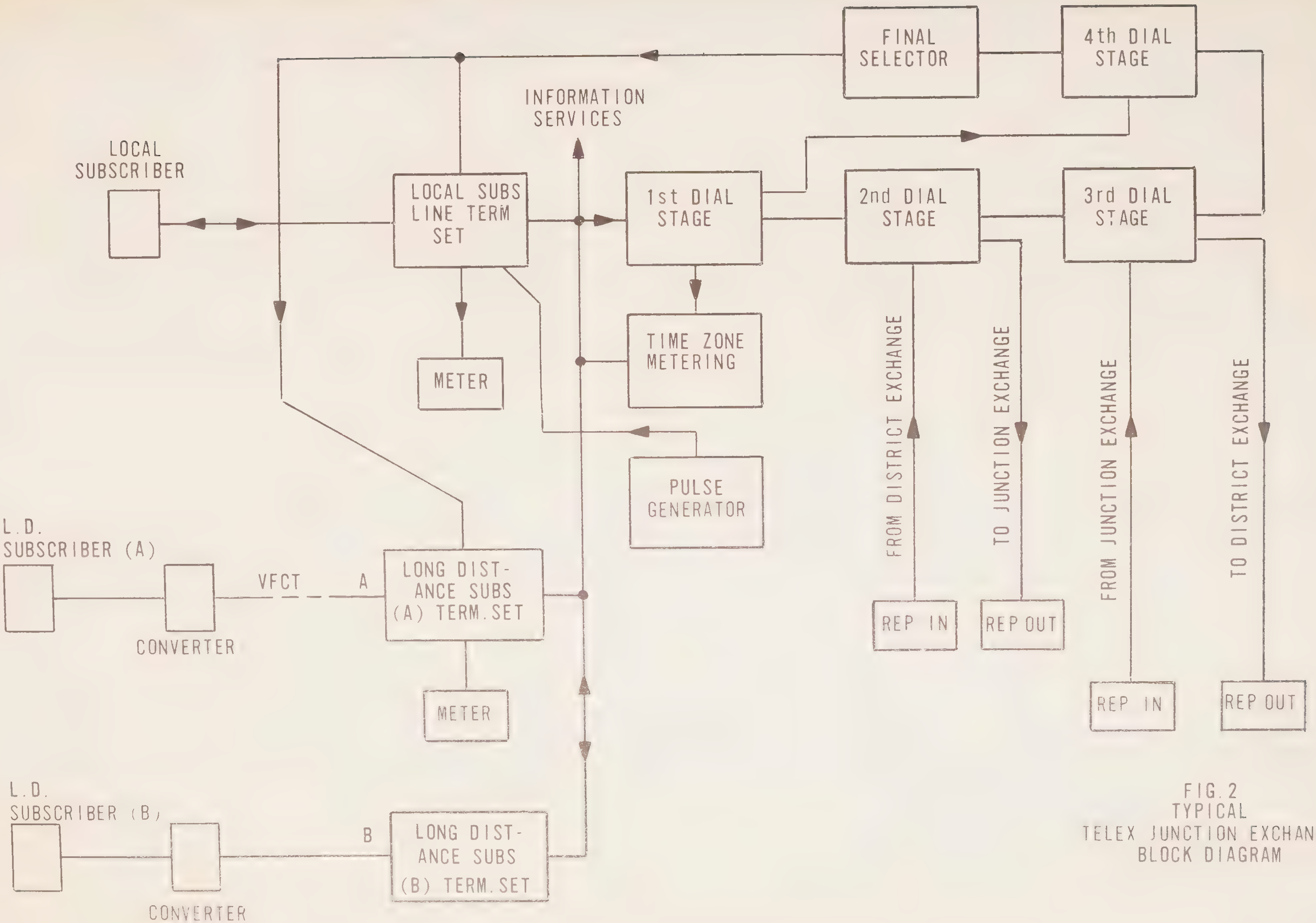


FIG. 2
TYPICAL
TELEX JUNCTION EXCHANGE
BLOCK DIAGRAM

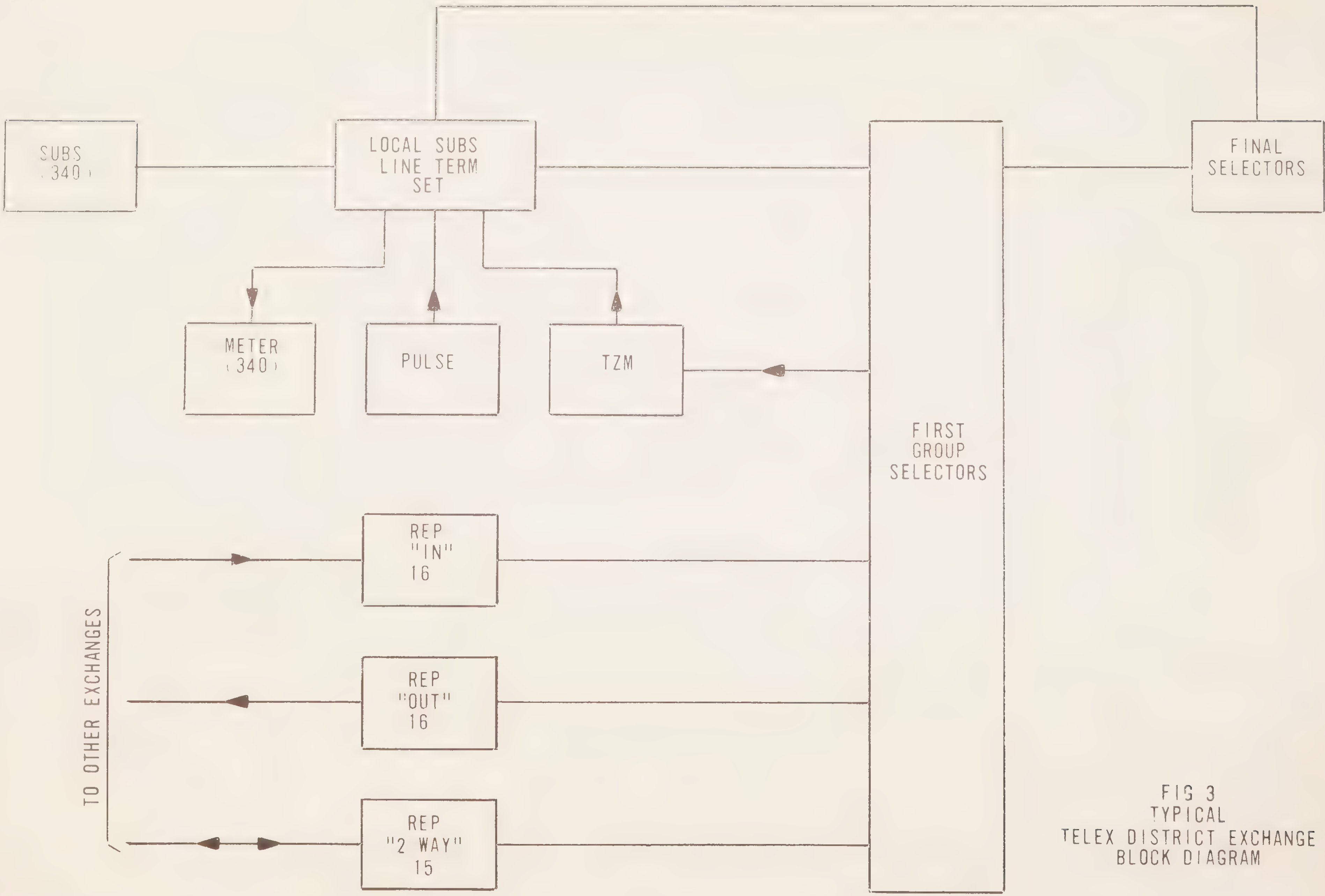


FIG 3
TYPICAL
TELEX DISTRICT EXCHANGE
BLOCK DIAGRAM

CONCENTRATOR LAYOUT

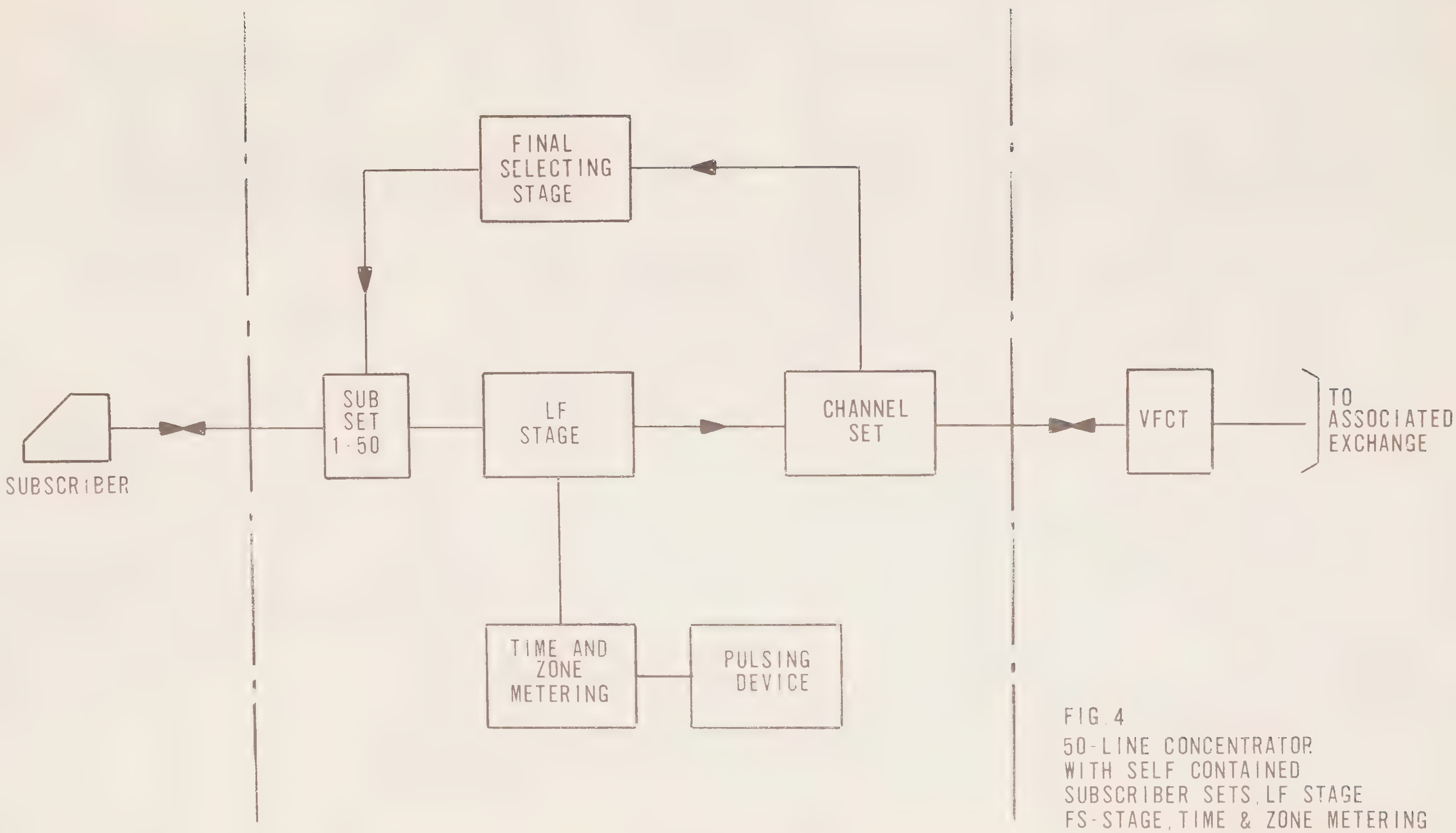


FIG. 4
50-LINE CONCENTRATOR
WITH SELF CONTAINED
SUBSCRIBER SETS, LF STAGE
FS-STAGE, TIME & ZONE METERING
APPARATUS & CHANNEL TERM SETS

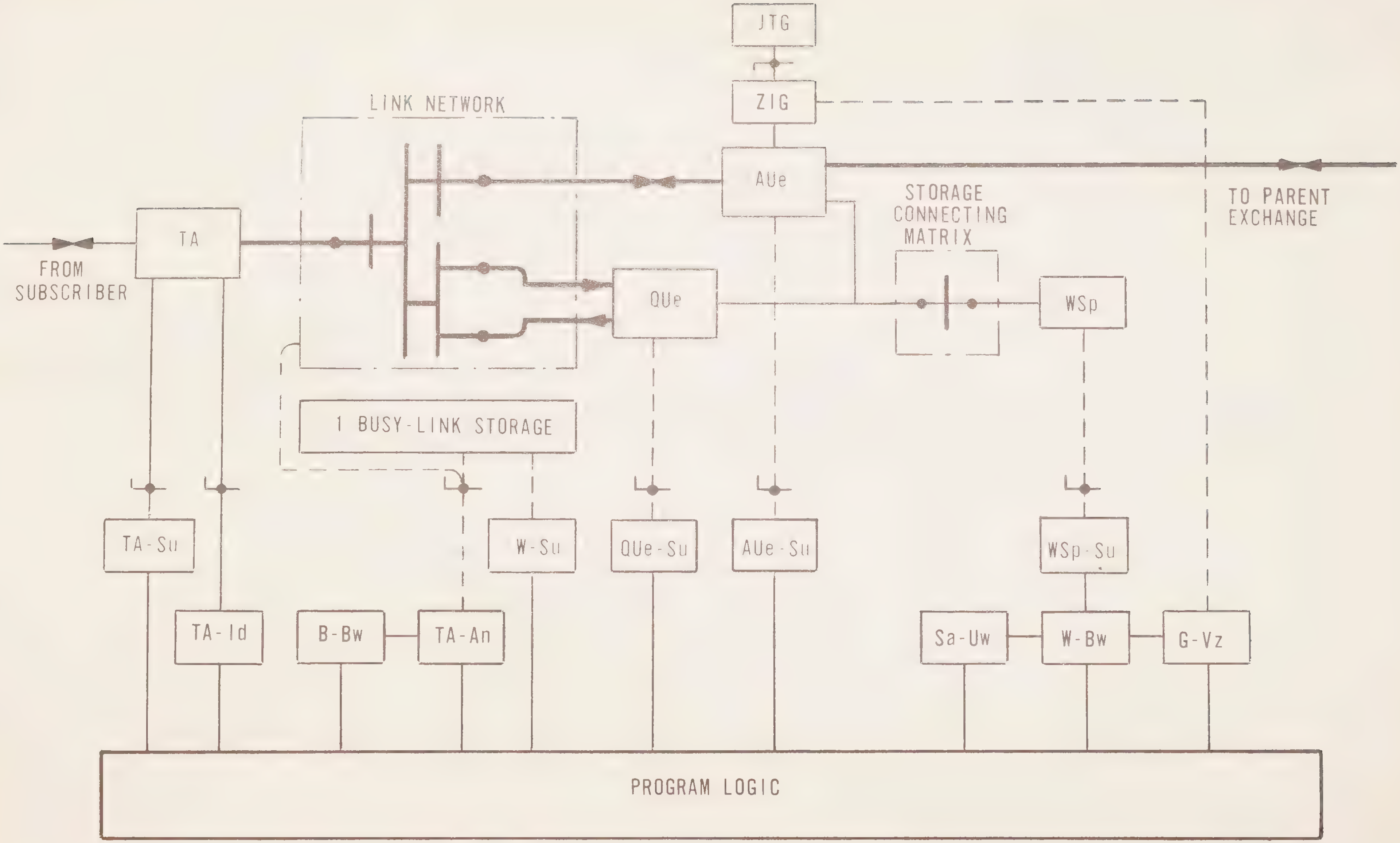
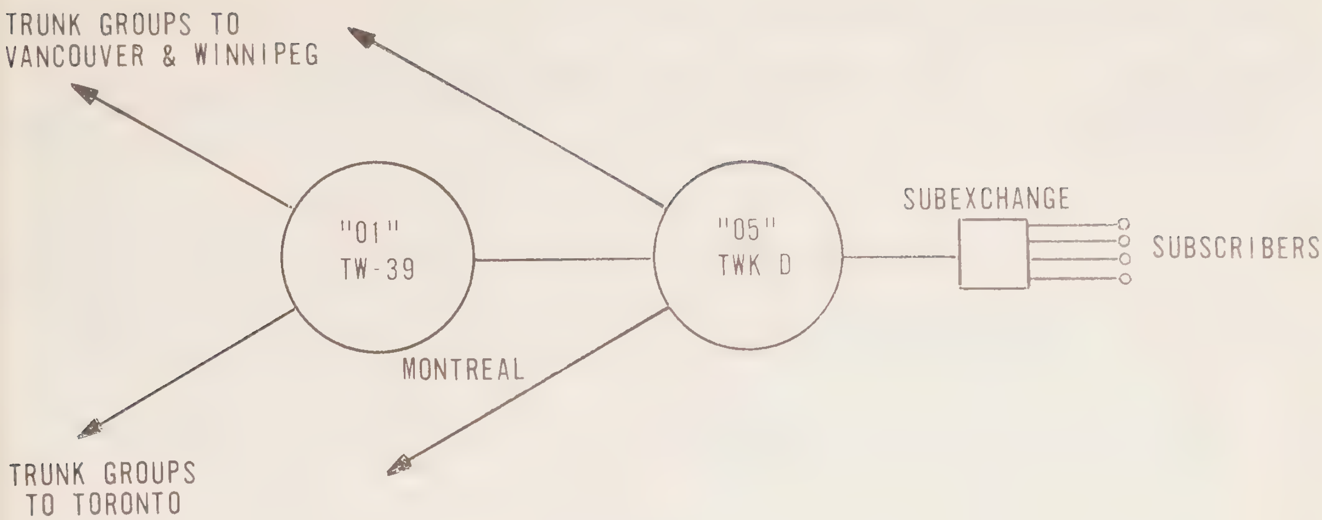


FIG.5
BLOCK DIAGRAM
OF TWK



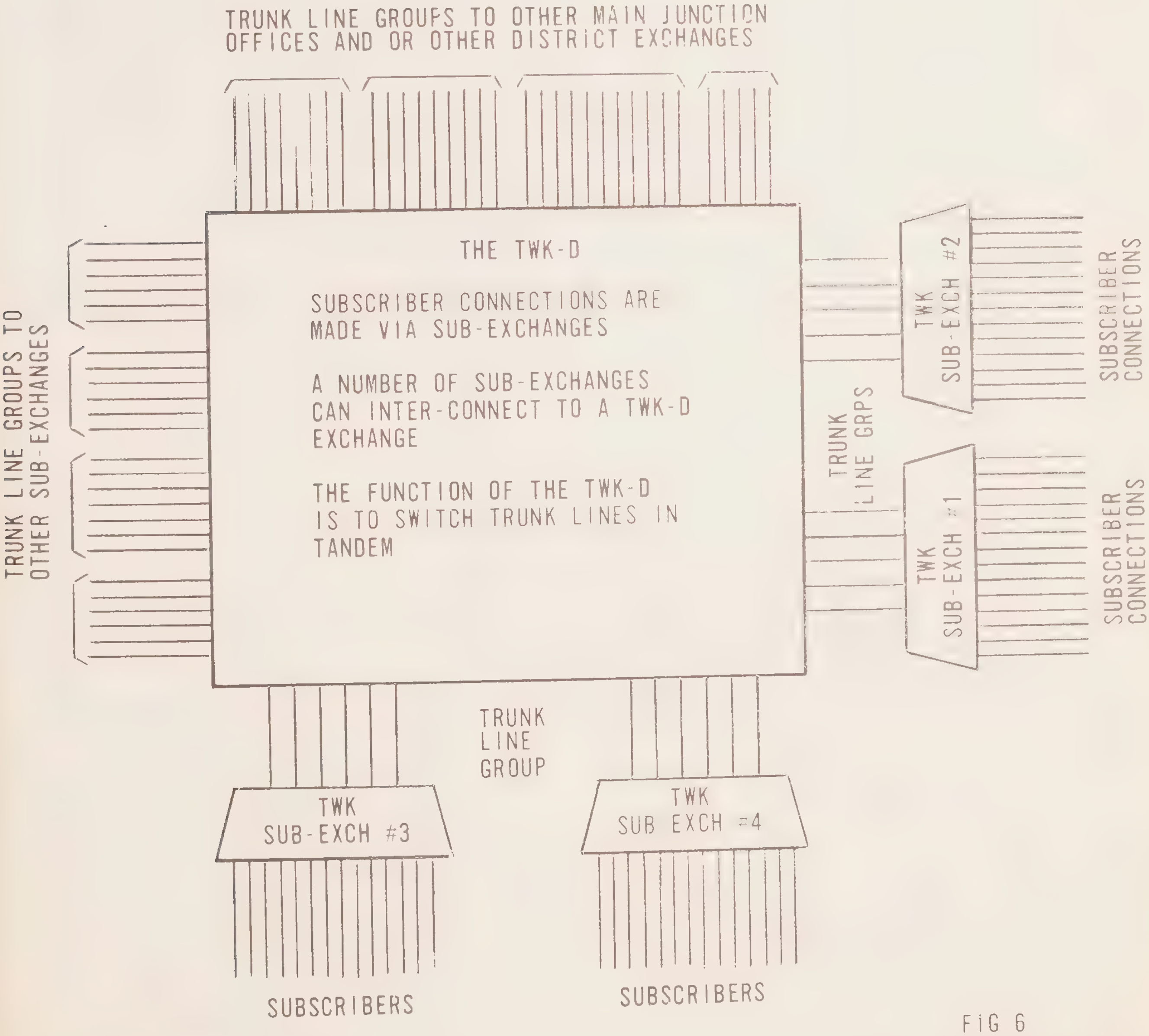


FIG 6

THE INCORPORATION
OF TWK-D EXCHANGE

SPECTRUM	CHANNEL SPACING									
	OPTION 1		OPTION 2		OPTION 3		OPTION 4		OPTION 5	
	170Hz		340Hz		240Hz		SPECIAL		SPECIAL	
	CENTRE FREQUENCY Hz	CHANNEL NUMBER	CENTRE FREQUENCY Hz	CHANNEL NUMBER	CENTRE FREQUENCY Hz	CHANNEL NUMBER	CENTRE FREQUENCY Hz	CHANNEL NUMBER	CENTRE FREQUENCY Hz	CHANNEL NUMBER
0.3-3.4 kHz	425	1	510	31	480	101				
	595	2	850	32	720	102				
	765	3	1190	33	960	103				
	935	4	1530	34	1200	104				
	1105	5	1870	35	1440	105				
	1275	6	2210	36	1680	106				
	1445	7	2550	37	1920	107				
	1615	8	2890	38	2160	108				
	1785	9	3230	39	2400	109				
	1955	10			2640	110				
	2125	11			2880	111				
	2295	12			3120	112				
	2465	13								
	2635	14								
	2805	15								
	2975	16								
	3145	17								
	3315	18								
3-5.2kHz							3550	21	3650	41
							3750	22	4050	42
							3950	23	4470	43
							4150	24	4930	44
							4360	25		
							4580	26		
							4810	27		
							5050	28		

FIG. 7

Trans-Canada Telephone System

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P.O. Box 462, Ottawa 2, Ont.
Telephone 613 239-5997
TWX 610 562-1941

N. C. Phemister
Assistant Chairman
and Secretary

July 29, 1970

Mr. G. Davidson
Department of Communications
Berger Building
100 Metcalfe Street
Ottawa 4, Ontario

Dear Mr. Davidson:

RE: Telecommission Study 8 (b) ii

We are submitting, herewith, papers on behalf of Trans-Canada Telephone System.

1. Paper on the Interconnection Between the Two Major Competing Common Carrier Organizations.

2. Paper on Technical Considerations of Interconnection.

Yours truly,

Assistant Chairman
and Secretary

LBS:gm

Enclosures

RECEIVED
JUL 29 1970
NATIONAL TELECOM.

CP Telecommunications
Suite 418, Place du Canada, Montreal 101, Que

Taylor
Engineer

File - A1/SF/118-8(b)

Montreal, July 17, 1970.

Mr. G.K. Davidson,
Terrestrial Systems Consultant,
National Telecommunications Branch,
Department of Communications,
100 Metcalfe St.,
Ottawa 4, Ont.

Telecommission Study-8B(ii)

Dear Sir,

Enclosed herewith are four copies of Canadian National - Canadian Pacific Telecommunications submission in response to Telecommission Study - 8B (ii).

While the Profile of Work Program calls for a study of Interconnection of Telex -TWX circuits, our submission has been enlarged in accordance with your letter of March 10, 1970 to cover the broader issues of "Carrier to Carrier Interconnection".

We would appreciate your classifying this submission as confidential to the Telecommission pending your receipt of formal submissions from all interested parties. At that time we would be agreeable to an exchange of submissions with other parties if they so wish.

We would be pleased to meet with you at any time to review our position on interconnection, if questions arise which you would like to explore in greater depth.

Yours very truly,

C.W. Taylor

C.W. Taylor

TEL. 866-8701
AREA 514 RÉGION

CANADIAN OVERSEAS TELECOMMUNICATION CORPORATION
LA SOCIÉTÉ CANADIENNE DES TÉLÉCOMMUNICATIONS TRANSMARINES

ENGINEERING AND OPERATIONS DEPARTMENT
DIVISION DU GÉNIE ET DES OPERATIONS

625 BELMONT STREET
MONTREAL 101

625 RUE BELMONT
MONTRÉAL 101

OUR REF.: NOTRE RÉF.: V1-1/3/70/JSC/ 686

YOUR REF VOTRE RÉF

MAY 21 1970

Mr. G.K. Davidson,
Terrestrial Systems Consultant,
National Telecommunications Branch,
Department of Communications,
100 Metcalfe Street,
Ottawa,
Ontario.

Dear Sir,

Telecommission Study 8b(iii)
Special Studies - Interconnection of Terminal Devices

This refers to the questions listed in your telex of May 15th 1970 and confirms replies provided during telephone discussion between Messrs. Davidson/Crispin on May 19th 1970.

QUESTION 1 What is the predicted life of the COTC special Telex/TWX code conversion equipment?

ANSWER 1 The equipment is considered to be highly reliable and a total life of 25 years would be a reasonable estimate. However, COTC will be replacing this equipment with its new computer controlled telex centre which goes into operation in the last quarter of 1970.

QUESTION 2 Is COTC making plans to expand its capacity and if so, have you budget figures for installed costs?

ANSWER 2 No, as implied above no further special conversion equipment will be purchased. The original conversion equipment was approximately $20,000 per unit but this cost is somewhat out of date.

QUESTION 3 If the conversion services were no longer required what impact would this have on the COTC operations in terms of operating costs and personnel.

ANSWER 3 The operating costs and personnel may be considered under two headings :-

3.1 Equipment Maintenance Costs

3.2 Operator Assistance costs

3.1 The COTC costs for equipment maintenance have been very low and if there is a telex or TWX switching centre proximate then costs of less than one-half a man would be allocated to the TWX/telex converter maintenance.

3.2 Regarding the operator assistance costs, these have also been low, however, the important point is probably that when a new system is introduced, it is considered desirable to provide special assistance operators for the convenience of the subscribers and in the COTC case, for enquiries from overseas administrations. Assistance operating positions for TWX/telex would desirably have special features related to this conversion, but the amount of assistance would probably be no more than that required within say, the present Canadian telex service when the new system has settled down.

We trust that this information is sufficient for your needs and we will, of course, be pleased to answer any further enquiries.

Yours very truly,

J. S. Crispin

J. S. Crispin, Chief Engineer, Engineering

RL.

APPENDIX E

TRANS-CANADA TELEPHONE SYSTEM

Issue 3
20 Jul 70

Technical Considerations of Interconnection

CONTENTS

Section 1

Introduction

The purpose of this paper is to provide some technical background for discussion of interconnection of the public address switched network and private lines provided by the telecommunications common carriers, with

(a) privately owned systems,

(b) other carriers facilities, and

(c) privately owned terminals.

One of the main objectives of the Trans-Canada Telephone System is to protect and improve the Telecommunication environment for all users. The present network has evolved over a period of 90 years from very crude beginnings to its present reliable and capable status. The repetitive cycle of research followed by development, followed by experience, followed by research etc. is the process which has led to this situation. The present design characteristics of the network are based on the probability of a variety of things either happening or not happening and this probability is based in turn on a great deal of experience. The design of the Telecommunications network is, in reality, an economic balance between the risk of certain known or recognized things happening and the necessary controls which prevent untoward things from happening - obviously a balance between risk and control must be experience rated, i.e. based on past experience or "probability" even though modern computor techniques provide a good initial design basis. Taking risk which is not experience rated can lead to serious service disruption and the obvious economic consequences. The Trans-Canada Telephone System operates on the basis of experience rated or "known" risk.

The basic technical problem of interconnecting things to the Trans-Canada Telephone System's telecommunication network is to adequately control the risk of polluting the network with signals, systems,or procedures which will interfere with other users or degrade the services offered. The risks must be carefully evaluated along with the attendant economic penalties.

Danger to the system and its users from interconnection, whether physical or otherwise, is not experience rated simply because sufficient time has not elapsed to gather this experience. It is just as undesirable to permit connection of anything and everything, willy-nilly, to the network, as has been shown in Europe and Asia(where PTT's have been obliged to impose strict controls on connection of customer owned terminals and systems), as it is to prevent connection for logical and reasonable uses. One of the biggest difficulties in interconnection is that of identifying sources of trouble, first to identify that a trouble exists before it affects other users, and then to identify what has caused the problem and what must be done to solve it.

In essence we are considering risk and how to control it. By taking careful and deliberate action now and avoiding precipitate decisions (which could result from pressure from manufacturers or customers), experience gained will show the direction to follow without producing any catastrophic effects.

The following sections outline the characteristics of the Canadian Telecommunication System and some of the characteristics which must be given priority consideration in any discussion of interconnection.

In these sections "private lines" refers to leased transmission facilities dedicated to, and designed for a specific customer by the Canadian Telecommunications companies and which does not interconnect with the public address switched network.

Section 2

A) Canadian Telecommunication System Description

The simplest form of a communicating system consists of two terminals connected together by a pair of wires. (A terminal is here understood to be the point at which information enters or leaves a communicating system). Although there are many such systems in use (public address, intercommunication, etc.) they are all of a very local nature and do not form part of, or make use of any more extensive systems.

The Canadian Telecommunication System in which we are interested is much more complex. Figure 1 is the classical and familiar picture showing the typical make-up of the system. The differences between switched network and private line facilities are that the switched network is an "anywhere-to-anywhere" system switching on demand while private lines are specially engineered between specific points, to meet agreed parameters, and covered by individual contract. Both types of services are carried over common transmission routes or systems.

If we temporarily ignore the private line facilities, Figure 1 can be used to illustrate how the toll (long distance) switching plan operates. In the present toll switching plan there are five ranks or classes of switching centres. The highest rank is the Regional Centre. The lowest rank, called the End Office, is the telephone exchange in which the subscriber's loops terminate. The order of route choice at each control centre is indicated in Figure 1 by the numbers in parentheses. In the example there are ten possible routes for the call, only one of which requires the maximum of seven intermediate links. (The number of links refers to the number of toll trunks or circuits in tandem or end-to-end from toll centre to toll centre). Note that the first choice route involves two intermediate links. In many cases, a single link exists between the two toll centres and this would be the first choice route.

The probability that a call will require more than N links in tandem to reach its destination decreases rapidly as N increases from two to seven. First, a large majority of toll calls are between end offices associated with the same Regional Centre. The final routes in these cases will not extend as far as the Regional Centre, and may not involve even the next lower ranking centres in the chain. The maximum number of toll trunks in these connections is, therefore, less than seven. Secondly, even a call between telephones associated with different Regional Centres is routed over the maximum of seven intermediate toll links only when all of the normally available high usage trunk groups are busy. The probability of this happening in the case illustrated in Figure 1 is only P^5, where P is the probability

that all trunks in any one high usage group are busy (there are five high usage groups shown in dashed lines in the figure). Thirdly, many calls do not originate all the way down the line since each class of office has all the duties (in its area) of all lower classes.

Table 1 clarifies these points. The middle column of this table shows, for the fictitious system of Figure 1, the probability that the completion of a toll call will require N or more links between toll centres, for value of N from 1 to 7. In computing these probabilities the assumptions that we used in this instance are: that the chance that all trunks in any one high usage group are simultaneously busy is 0.1; that the solid line routes are always available; and that, of the available routes, we always select the one with the fewest links. The figures in Table 1 illustrate how increasingly unlikely are the connections requiring more and more links. These numbers are, of course, highly idealized and simplified. Actual figures from a survey are shown in the last column of Table 1. Note that 80% of calls were completed over only one intermediate link (this is not possible in the system shown in Figure 1, which does not show a direct trunk between toll centres) and that as many as seven intermediate links were required in only 3 out of 100,000 calls. It is experience with probability information such as that just described which has permitted the TCT System to strike an economic balance between the risk of a user being unable to make a call because all circuits are busy and the cost of providing sufficient circuits and equipment such that no one would ever encounter a condition of all circuits busy. (The situation where the called party is busy is a separate one to that where all circuits are busy).

It is apparent that the switching pattern that has been described imposes strict transmission requirements on toll trunks. Up to seven toll trunks may be connected in tandem, and successive calls between the same two telephones may take different routes and encounter different numbers and kinds of circuits. The loss must not be excessive when calls are routed over the maximum number of links, and there should not be too great a variation in the transmission quality afforded over the different possible routes that a call might take. Loss cannot be permitted to get too low either or echo, singing, crosstalk, and noise can cause excessive transmission impairment. In the days when circuits were controlled manually on a manual link patching basis by operators, maintenance was carried out on a "call out" basis where a defective circuit would be identified and repaired. The same economic requirements and technological changes that have led to automatic switching of long distance circuits have also required that maintenance must now be carried out on a routine basis and the design of the switching apparatus, the maintenance test

equipment, and the maintenance procedures have all changed to accommodate this. As economics and technology continue to change in the future, so will the methods of design and maintenance, on a carefully planned basis and timetable.

Figure 2 shows in more detail the circuit make-up of a typical terminal to terminal connection. Here again the difference between switched network and private line facilities is that the private line by-passes the switching equipment and is custom designed. A connection may involve transmission between terminals through a single central office, or through a number of links including several offices, cable facilities and carrier systems. The terminal located on the subscriber's premises generates or receives the information to be transmitted, generates supervisory signals to indicate to the local central office the status of the terminal, and generates the signalling information to indicate to the switching system what connections are to be made and to initiate charging. The local central office must, of course, correctly interpret the information it obtains from the terminal and pass on to the toll centre the information necessary for the latter to carry out its tasks. The toll centre must in turn perform functions based on the information it receives from the local central office and so forth.

It is easy to see that each entity in the chain between terminals, including the terminals, must complement all other entities if the system is to operate properly. Years of experience in many fields has permitted the Trans-Canada Telephone System to allot to each portion or entity of the overall system appropriate transmission parameters and limits, based on the theory of probability and considering the economics of risk versus control which permits these portions to work together to provide the desired end-to-end transmission quality and behaviour. It should be apparent at this point that a malfunction anywhere in this chain can make itself felt over a considerable distance.

The toll trunk in Figure 2 is called a four-wire system since the signals in opposite directions go on separate paths. These facilities are usually microwave radio or cable carrying a number of trunk circuits or channels by means of carrier multiplexing in which individual voice grade channels are combined for economical transmission. A much more complete treatment of frequency division multiplexing can be found in Chapter 5 of Reference 1.

Inherent in any transmission system are small amounts of residual imperfections (i.e. non-linearities, envelope delay distortion, etc.). These imperfections generate intermodulation distortion which causes some intermixing of the individual channel signals that make up the

multiplex signal. The effects of this intermodulation distortion become more pronounced as the signal power (load) applied to the system is increased, and result in an increase in the noise level within individual channels. This noise can take the form of intelligible crosstalk if the high level signals have strong single frequency components.

Thermal noise (hiss) exists in addition to the noise generated by intermodulation distortion. This thermal noise is generated in the electronic circuitry which makes up the system and is independent of system load whereas the intermodulation noise increases rapidly with increasing signal power.

In developing a transmission system the designer is faced with striking a balance among (a) required load carrying capacity, (b) thermal noise, (c) intermodulation noise and (d) cost. (See Chapters 7, 10 and 12 of Reference 1). In general, the transmission system is designed to have the lowest possible cost while meeting the required load carrying capacity and noise objectives. Greater load capacity or better noise objectives result in more expensive systems.

In most system designs the signal to noise ratio is an important operating parameter. To achieve the optimum signal to noise performance it is desirable to select an operating point for this system at which thermal noise and intermodulation noise are appropriately balanced. Figure 3 illustrates the relationship among signal power, thermal noise power, and intermodulation noise power as a function of the input signal power. As the input signal increases from a low power level the signal-to-noise ratio gradually increases to a point at which the optimum signal-to-noise ratio is reached. Beyond this point the intermodulation noise increases more rapidly than the output signal power. As a result the overall signal to noise ratio tends to decrease.

From this figure, as one would expect, if the input signal exceeds those for which the system was designed increased noise would be encountered. However, the intermodulation noise increases at a far faster rate and Figure 4 shows how the probability increases rapidly that energy in one channel will appear as intelligible energy in another channel (crosstalk). This is one of the most serious forms of overload in that the crosstalk will not appear in the channel that is doing the overloading but rather its results will appear in other channels. It is insidious in that a strong signal in channel A can cause the information in channel B to appear in channel C unknown to the users of either channel A or B. On the other hand if the signal energy in channel A is maintained at or below the design maximum for the system, intelligible crosstalk is very unlikely to occur. Situations of the type just described can conceivably occur at any point in the system outlined in Figure 2 but the results may be detected only thousands of miles away. This discussion points out the necessity for each entity of the system to be designed and maintained as part of, and complementary to the overall system.

Terminal Characteristics

In order to design any system, characteristics of the terminal must be established. The major terminal on the voice portion of the system is the telephone. It is designed to interface with the human head for the exchange of information. Many subjective assessments of various aspects of telephone transmission quality have been made to determine what is poor, fair, good and excellent from the point of view of the user. Figure 5 is an example of such a subjective appraisal, this one concerned with the noise received by the terminal from the system. Knowledgeable interpretation of this information permits a maintenance level of acceptable noise to be chosen which is both satisfactory to the user and economical to the system.

Similar subjective appraisals, using a large number of subjects, have produced information indicating the acceptable volume level and its range of acceptable values in received signals and also the levels of signals to be expected at the central office from the customer's location.

Using such information the many entities of Figure 2 have been designed and upgraded through the years to provide good end-to-end communication. (Reference 2 is a classic example of this type of information which is still a standard reference for the design of carrier systems).

Based upon the distribution of talker volumes and the characteristics of modern telephones, long haul microwave and cable carrier systems currently in use are designed to meet noise objectives and to provide the optimum signal to noise performance with a 4 KHz channel load of -16 dBm0 long term average power (dBm0 means dBm at the 0 Transmission Level Point). This long term average power level has also been adopted as the objective for future designs of long haul frequency division multiplex carrier systems.

The -16 dBm0 load is the maximum average load power for a voiceband channel that can be tolerated without incurring a noise penalty if every channel were used for transmission simultaneously in both directions. However, most users do not use both directions of transmission at the same time and not all channels are active at the same time. It is, therefore, required to convert the long term objective per channel for the system to an acceptable limit for an individual user's signal power. Experience shows that the average percentage of time a channel is switched into a connection during a busy hour for long haul carrier systems is about 70% (10 log 100/70 = 1.5 dB) while a factor for transmission in one direction at a time is 0.5 (10 log 1/0.5 = 3 dB). Using these factors, the operating signal level permitted at the 0 Transmission Level Point is calculated as follows:

Full Duplex	
Long Term Load Objective	-16 dBm0
Adjustment for 70% usage	+1.5 dB
Permissible Load per Channel	-14.5 dBm0
Half Duplex	
Long Term Load Objective	-16 dBm0
Adjustment for 70% usage	+1.5 dB
One-way Transmission	+3 dB
Permissible Load per Channel	-11.5 dBm0

To accommodate the mix between full and half duplex services and also to control intelligible crosstalk caused by high level tones, a compromise of -13 dBm0 has been adopted. Since there is normally a 1 dB loss between the central office switching equipment and 0 Transmission Level Point an average power level of -12 dBm0 was adopted for general application. These levels, of course, apply to energy within the normal voiceband of 300 to 3,000 Hertz. Energy at higher frequencies must be appropriately reduced in power in order not to cause interference to carrier and signalling systems used in various parts of the entities outlined in Figure 2.

Figure 6 shows how the maximum acceptable signal level from the terminal decreases as the frequency is increased and takes into account the potentially disruptive effect this could have. These are current standards and, of course, will be changed as technology and usage require.

Transmission of data signals (from business machines) is also carried out readily on the Public Address Network and over Private Line Facilities. Here a data set becomes part of the terminal to convert the digital signals to and from signals compatible with the Telecommunication System. The data capabilities of the Public Network have been carefully investigated (see Reference 13) and equipment developed to offer a variety of services.

The future trends in network design will, as in the past, be a result of the research-development-experience cycle. Just as a major improvement in design of the telephone instrument (see Reference 6) permitted major improvements in transmission quality and economics (a saving to date of $6 M in Bell Canada alone for copper and an estimated savings of 10 times this amount in capital cost and administrative expense), so will the application of semi-conductors (see Reference 5) and pulse transmission systems (see References 3 and 4). These new technologies are being applied today as their degree of risk becomes predictable through experience.

The development of the new telephone set permitted longer and more economical subscriber loops to be used. Continued improvement along these lines is anticipated such as replacing the present 20 Hz high voltage ringing signal with a tone signal, the ultimate replacement of dial pulse with Touch-Tone signalling, and a number of other changes in the terminal-to-central office area which will result in even longer and more economical loops. Techniques are presently available which with appropriate development can be used to provide distributed switching of subscriber's loops remote from the central office. Telephone wire and cable is not restricted to handling voiceband signals (if this was the case carrier systems could not operate over these cables). Carrying services into the home which require wider than voiceband capabilities, such as picturephone, yesterday was a dream, today is possible and tomorrow will be practical, and in fact will be necessary as the trend develops from an employee spending his working day at his office to spending his working day carrying out his work in his home. Terminals to allow him to communicate with his fellow employees, his supervision and his other contacts can be built today, will be built tomorrow, and the signalling and the supervisory requirements for interaction between the terminal and the communicating system will, of necessity, change. These changes must be brought about in a planned and controlled manner if chaos is to be avoided.

B) Characteristics of TCTS Local (Exchange) Plant

Figure 2 illustrated the various parts of the terminal system. As was pointed, out the design of each of the entities which make up this system are very much interrelated. It is proposed now to take a closer look at the loops which inter-connect the terminal with the local central office. Loops are generally provided by means of pairs of wires grouped together into cables. As one would expect the physical and electrical characteristics of the loop plant have a considerable effect on signalling and supervision, as well as on the safety of personnel. These characteristics will be considered briefly.

Signal Characteristics

The manner in which the local telephone plant is arranged and installed has been developed over a long period of time using experience gained to develop better methods and provide economically a suitably low risk from service interruption or deterioration. This arrangement meets the objectives of (1) protection to prevent hazard to life and property; (2) transmission capability required to permit the faithful transmission of the desired information and in addition of the necessary signals and supervision; (3) appropriate design to minimize interference between telephone circuits and from power systems; (4) flexibility (i.e. the ability to provide services rapidly anywhere in the area served); and (5) a reasonable cost.

The subscriber Loop

Figure 7 shows a simplified sketch of the loop network covering a typical service area. All circuits intended to serve a particular part of the service area leave the central office in a large feeder cable, in this case consisting of 2700 pairs. In the central office the feeder cable is connected to the main distributing frame by means of other cables and from here, as the name implies, distributed to terminals on the switching equipment.

As service to the area requires the feeder cable is connected or spliced to other smaller cables, called distribution cables which may well be further divided into smaller cables at splice points until the cable terminal is reached at which point the drop connects a pair (or pairs) to the station protector at the customer's premises.

It is obvious from Figure 7 that telecommunication craftsmen have access to the pairs of wires at many places along the routes at different points in time. From time to time the routes change and the points at which cables join and the size of cables are changed to allow for growth and modification. There are an average of about 10 splice or access points on each telephone loop and the average loop is re-arranged at some point about once every two years.

Electrical Characteristics

The electrical characteristics of the loop plant may be divided into two groups, viz. (i) Those which are concerned with transmission over the loop such as attenuation, bandwidth, impedance, etc. and (ii) those relating to cable balance, i.e. inter-action between loops within a cable or with other elements of the surroundings (crosstalk, electrical induction, etc.)

Characteristics in the first group control quality of transmission performance and signalling. The design installation and maintenance practices of the TCTS, which have been developed over many years' experience, coupled with careful design and construction on the part of the cable manufacturer control these characteristics to the degree dictated by reasonable risk and cost. Characteristics in the second group, if not carefully controlled can cause undesired crosstalk between pairs in the cable as well as being induced with undesired potentials when exposed to the inductive fields from power distribution systems.

(i) Transmission Characteristics

The subscriber loop function is to carry information backwards and forwards between the terminal and the central office. It presents resistance to the passage of DC currents, attenuates or reduces alternating current energy (voice signals for example), and, if improperly designed or used, can produce crosstalk. (See next section, Cable Balance)

Loops normally consist of pairs of copper wires arranged in cables (Bell Canada alone has 4,000,000 working loops). They vary widely in length and size (gauge) of wire used, and are the most expensive single investment directly associated with a particular subscriber's service. Typically, in Bell Canada, the average investment for a 10,000 foot loop is $200, for a 20,000 loop is more than double at $500, and 90% of all loops are 20,000 feet long or less. (The cost of adding to, or renewing existing plant is considerably higher - typically $350 for a 10,000 foot loop for example). In some areas of Canada local conditions such as low population density and long distances result in considerably greater loop complexity and cost.

Since the cost of an installed telephone including wiring is about $60 and the cost of the directly associated equipment in the central office excluding switching equipment is between $36 and $60, the telecommunication industry expends a great deal of effort to reduce the cost of loops. One logical means of cost reduction is to use less material and this is done by using finer gauge cables. Much new plant uses 26 gauge wires as compared to the earlier heavier gauges but thinner wire increases the resistance and attenuation for a given length and this must be compensated by changes in the terminal and/or central office in order to maintain the over all transmission quality and control.

The electrical characteristics of loops also vary widely. In Bell Canada the loops have a mean DC resistance of about 500 ohms and a standard deviation of about 400 ohms. It has a mean 1 KHz insertion loss of 3.3 dB with a standard deviation of 2 dB and at 3 KHz a mean insertion loss of 7.4 dB with a standard deviation of 4.2 dB. These variations must be accommodated in the design of signalling, supervision, and transmission objectives for the overall system.

A series of improvements over the years has permitted economies in provision of service and improvements in quality. For example early telephones were quite inefficient and quite insensitive and required batteries at each location. The wire used to connect these stations to the central office was large and, by today's standards, would be quite impossible to provide because of cost and space considerations. The 300 type set offered a total improvement of 15 dB (the sum of the improvements in transmitter and receiver efficiency) over earlier sets. The 500 type set (see reference 6) offered an improvement over the 300 type set of a further 7.5 dB. These two sets together have therefore provided an improvement in excess of 20 dB in efficiency, and 20 dB is equivalent to an increase in sound intensity of 100 times. The 500 type set in addition is designed to partially compensate for the increase of loop loss with distance from the central office. It is changes such as these which have permitted use of the fine gauge cables with their resulting economies.

(ii) Cable Pair Balance

The coupling of energy among pairs of a multipair cable and the coupling of energy from outside sources into the pairs must be controlled so that individual pairs may be usable as separate transmission channels.

This control is achieved by
- limiting signals or noise power
- maintaining coupling to noise and signal sources
- reducing the susceptiveness to noise and other signals.

The signal or noise power is controlled by suitable design of terminals, central office equipment, and external energy sources. Coupling is controlled by balancing mutual impedance between the undesired energy source and each side of the affected circuit. Susceptiveness is controlled by longitudinally balancing the self impedances (series, shunt and switching) of each side of the affected circuit.

Energy is coupled to cable pairs from outside sources primarily through mutual inductances. Energy is coupled among cable pairs primarily through mutual capacitances. This coupled energy becomes distrubing only if the longitudinal balance of the self impedances is inadequate

Figure 8 shows (schematically) two wire pairs of a multipair cable, designated Pair A and Pair B. Typically, for cables used for loops, the capacitance between the two conductors of a pair (designated, conductor T and conductor R) is about .085 microfarad per mile. Each conductor of a pair also has an equivalent capacitance to ground of about .09 microfarad per mile. In addition, each conductor of a pair has a capacitance to each conductor of other adjacent pairs of approximately .007 microfarads per mile.

The direct paths by which energy is coupled between pairs are the interpair capacitances, C1, C2, C3, and C4 on Figure 8.

In order to explain the crosstalk mechanism, a voltage generator, e_B, is shown connected to Pair B. Setting aside, for the moment, the effects of the wire-to-ground capacitances, C5, C6, C7, and C8, we can assume that the voltage-to-ground of the T conductor of Pair B, e_{TB}, is equal in magnitude but opposite in polarity to voltage e_{RB}. If C1 equals C2, then the voltage coupled to the T conductor of Pair A from T of B through C1 would exactly cancel the voltage coupled from R of B through C2. Similarly, the voltages coupled to the R conductor of Pair A through capacitors C3 and C4 would also cancel. Hence, no net metallic voltage would be developed on either the T or R conductors of Pair A. That is, although there would be a non-interfering longitudinal voltage, there would no interfering metallic voltage directly coupled to Pair A. Then, as long as the self-impedances of Pair A are balanced, there would be no conversion of the coupled longitudinal voltage to metallic voltage. These pair-to-pair capacitances are controlled

quite carefully in manufacture and the difference among the capacitances associated with any two pairs (or as it is called, the pair-to-pair capacitive imbalance) is typically less than .0001 microfarads per mile. In fact, for purposes of explaining crosstalk coupling, this pair-to-pair imbalance may be neglected.

The capacitance of the wires to ground, however, is not as closely controlled in manufacture. Hence C7 does not equal C8 and e_{TB} and e_{RB} to the conductors of Pair A are not completely cancelled, and a net voltage is induced in Pair A. (Similarly differences between C5 and C6 also cause a voltage to be induced in Pair A.)

As it turns out, the factors that control crosstalk between any two pairs in a cable are: (1) the magnitude of the interpair capacitance, C1, C2, C3, and C4, which is a function of the proximity of the two pairs within the cable; (2) the degree of imbalance (or difference) among them; and (3) the degree of balance (or matching of series impedance and impedance to ground) of the individual pairs, which is determined partly by C5-C6 and C7-C8. This last condition determines the degree of balance.

Longitudinal Balance is defined as the ratio of the disturbing longitudinal voltage (V_s) to the resulting metallic voltage (V_m) expressed in decibels as measured at the terminal (s) of the network under test:

$$\text{Longitudinal Balance} = 20 \log \left/ \frac{Vs}{Vm} \right/ \text{dB.}$$

(see Ref 14).

The degree of longitudinal balance in cables is controlled by design so that the crosstalk coupling loss between pairs is generally well over 100 dB with about one percent of pairs having coupling losses of 80 dB or less at 1000 Hz. Since this coupling is primarily capacitive, the coupling loss will decrease (hence crosstalk will increase) with increasing frequency at the rate of 6 dB each time the frequency is doubled. However, to achieve these levels of crosstalk loss,it is necessary that the balance to ground at the terminations of the pairs also be controlled. Tests have shown that if one conductor of both pairs is grounded, crosstalk will be increased by as much as 60 dB.

Central office circuits and terminal equipment and wiring provided by the TCTS are carefully designed, installed, and maintained to insure a high degree of balance to ground. However, equipment, even when suitably designed and manufactured, can be unbalanced to ground through improper installation.

Hence, one important factor in preventing interference to other customers through crosstalk is to insure that the line terminations in the terminal ARE balanced to ground.

Section 3

A) Safety

In the Telecommunication industry protection of customers, personnel, and plant from hazardous voltages has always been a prime consideration in design of the many entities of the system. When interconnection with plant owned by others is considered, the protection of personnel and plant from hazardous voltages induced from outside is of even greater significance since the Telecommunications supplier has little or no control over the design or condition of the interconnected plant.

Two factors are important to an understanding of the need for hazardous voltage protection. These are (1) the effects of electric shock on human beings and (2) the extent to which telecommunications personnel may be exposed to such shock.

(a) Effects of Electric Shock

The harmful effects of electric shock are determined, basically, by the amount of current passing through the human body. The amount of current that will flow through the body, in turn, depends on several factors: the voltage on the electric conductor to which the body is exposed, the source impedance of the voltage, and the highly variable body resistance. Body resistance consists of skin, or contact, resistance and internal body resistance. While the internal resistance of the body has a relatively fixed value of 300 to 500 ohms, skin or contact resistance can vary from 500 ohms to several hundred thousand ohms, depending on a number of conditions. Perspiration, wet electrodes, sharp electrodes such as a nail in a shoe, or puncture of the skin can result in much lower resistance.

In evaluating the shock hazards to the average craftsman in the TCT System, we have assumed total body resistance of 1500 ohms. This value is in line with the resistance value utilized by safety experts in other fields.

The actual path of current through the body is important in determining the extent of damage caused by electric current. Fatalities nearly always involve a path through the heart, but in practical safety considerations the particular path through the body cannot be assumed or taken into account. The following table describes the effects of 60 Hz alternating current on the human body:

AC Current (RMS)	Effect
1 ma	Perception threshold
5 ma or more	Painful shocks
10 ma or more	Local muscular contraction sufficient to cause freezing to the circuit for 2.5% of the population.
15 ma or more	Freezing for 50% of the population.
30 ma or more	Breathing difficult, possible unconsciousness
50 ma to 100 ma	Possibly fatal
100 ma or more	Generally fatal

The duration of the current flow is, of course, important. The values of current listed above, in the fatal range, need not have a duration over one second to be fatal. Tests on animals show that tolerance increases as shock duration decreases (see Refs 7 & 8).

While current is the parameter that determines the severity of shock, the voltage on an exposed conducting part is the only criterion that is practical for use in arriving at limits or guidelines for the protection of personnel. By translating the above current values, by means of expected body resistance, the industry has established longstanding limits on allowable voltage levels in the telephone plant. These limits are: for continuous AC voltages, 70 volts peak; for continuous DC voltages, 135 volts. Above these voltages, special protection for personnel is being required.

In the TCT System, the normal operating voltages are below these limits. Ringing voltage, which is 40 to 105V RMS 20 Hz superimposed on 48V DC, might appear, at first glance, to exceed the safety thresholds, but ringing is not a continuous voltage. It is interrupted and generally is on for two seconds and then off for four seconds. In addition, ringing supply circuits include sensitive "ring-trip" elements, which sense call answer by detecting the flow of current. These sensing elements (in the supply circuits) are required to function for all ringing operations. They will operate and remove ringing voltage within a small fraction of a second if a personnel contact causes sufficient current to exceed the trip threshold, which is in the range from 10 to 22 ma.

The widespread telecommunication plant is, of course, also exposed to foreign voltages: primarily lightning and high-voltage power distribution plant. Control must be, and is exercised to limit these voltages in the interest of protecting both craftsmen and customers from electric shock. Three techniques are employed to minimize the occurrences of electric shock: (1) the use of protectors and suitable bonding and grounding techniques, (2) the control of insulating properties of station wiring and equipment, and (3) the control of installation practices relating to allowable proximity to sources of foreign voltage.

The protectors that are presently used at central offices and at customer premises are of two types: (1) protectors which are used on all lines with exposure to lightning and power distribution systems, and (2) fuses and other current-interrupting devices which are used on lines exposed to power distribution systems.

The voltage sensitive protectors are generally air-gap breakdown devices utilizing carbon block electrodes. These protectors have a breakdown threshold in the 285 to 540 volt range, are fast acting, and are generally very reliable, provided that proper grounding techniques are used. A comprehensive treatment of bonding and grounding is outside the scope of this paper, but the basic requirement is that all grounds at a given location must be bonded together so that only one ground exists for telephone company equipment, customer equipment, and electric power systems, thereby minimizing voltage differences between separate grounds at the location. All company installers are carefully trained and a considerable amount of effort has been expended over the years in devising installation procedures and equipment to insure consistent, safe, installations.

Protector blocks used in the telephone system can allow up to an 540 volt lightning surge to pass through, but this is not a lethal level because lightning surges are of short duration. Based upon tests on animals, (see Ref 9) the minimum fatal energy for humans is taken to be 50 watt-seconds. An 540 volt lightning surge would need to last of the order of 100 milli-seconds in order to deliver this much energy to a human body, which is more than 100 times the duration of actual surges.

Furthermore, insulation properties of telephone company-provided equipment and wiring furnish protection to levels in excess of the 540 volts that may be passed by the protector blocks. This protection is achieved through appropriate design and manufacture, and most importantly through careful installation and maintenance practices.

The second type of protectors, current-interrupting, or fuse-type, are designed to protect against catastrophic damage to telephone equipment. When used in the central office, they are called heat coils and operate at a current of about one-third of an ampere.

(b) Extent of Personnel Exposure

As explained, the TCTS provides service to customers by means of physical conductors in the exchange plant. Each time service is installed, removed or repaired, craftsmen make physical contact with wire pairs and terminals at one or more points in the station equipment or at the terminal appearances of the wire pairs on customer premises, in outside manholes or on poles, and in the central office building.

In general, the work operations require a hands-on type contact. The size of the wires, the terminal sizes and spacings, and the dexterity required, generally preclude the use of protective clothing or devices such as rubber gloves. This is not to say that rubber gloves are never worn. They are prescribed for many construction operations, particularly when working on joint-use poles shared with power companies. But they are inappropriate for such tasks as splicing together multiconductor fine-gauge cables.

It is difficult to determine the magnitude of craftsman exposure. In the interest of appreciating more fully the extent of this exposure, a form of mathematical model was constructed which is designed to aid in the evaluation of exposure by generating a rough quantitative estimate.

Some of the physical characteristics of the loop plant were explained briefly in Section 2 of this paper. As described there, the conductors which leave a central office building are carried in densely packed cables, ranging from as few as 6 to as many as 3000 pairs of conductors per cable, and they are spliced together and terminated on closely spaced terminals in cross-connection boxes and in sealed splices along the routes.

One consequence of this compactness is that it is difficult for craftsmen to work on a pair of terminals (or a pair of wires) without contacting adjacent terminals (or wires). Therefore, craftsmen working on a single pair are exposed not only to that one pair at terminal field appearances, but also to additional pairs which are connected to adjacent terminals. The extent of this enhancement of exposure is a function of the actual terminal designs (horizontal and vertical separation of terminals, barrier sizes, etc) and the dexterity of individual craftsmen.

A model of a typical terminal field, which defines the immediate exposure area, is shown on Figure 9. This model is based upon a screw terminal field with typical terminal center-to-center spacings of 3/4 inch. (Newer, so-called quick-connect terminals, have spacings of 1/2 inch and less and the trend toward greater compactness is continuing). Assuming a conservative figure of length of exposure span somewhere between one and two inches, the model (Figure 9) arrives at an exposure enhancement ratio, which is the ratio of the number of terminals to which the man is exposed to the terminals actually worked upon, of 15 to 1.

An extension of the model is necessary to account for the overall exposure in performing a work function (e.g., installation of service) because of the multiple appearances of the wire pairs in several terminal fields along the route. Figure 10 derives an overall exposure enhancement ratio, and utilizing a numerical example based upon an assumption of work in four terminal fields per job (e.g., central office main frame, central office equipment frame, outside plant manhole terminals etc) suggests an overall exposure enhancement ratio between 30 and 60 to 1. In other words, the number of pairs of conductors (perhaps including a pair carrying a foreign hazardous voltage) that may be contacted by telephone company personnel is 30 to 60 times greater than the number of pairs of conductors that actually are required to be worked upon.

The next step in deriving an overall craftsman exposure scale factor is to determine the volume of work performed in the exchange plant. While this is a difficult figure to define precisely, a lower boundary can be found from work order and repair activity. For Bell Canada, there are over 0.3 million work functions per month involving contact with wire exchange plant, which is a rate of almost 10 contacts per 100 lines per month.

A reasonable estimate of overall exposure may thus be obtained by multiplying this figure of 10 contacts per 100 lines per month by the exposure enhancement ratio previously derived. Results of such a computation yield an exposure rate of about 300 to 600 exposures per 100 lines per month or 3 to 6 exposures per line per month. In other words, a craftsman contact occurs with each loop on the average of about once a week.

This estimate has been based solely upon work order data. In addition, there is the further exposure incurred during plant rearrangements which, as discussed in Section 2 B), are necessary for efficient utilization of the cable facilities. Consider, for example, a craftsman in the process of splicing together two large feeder cables. He may be sitting in a damp manhole with literally hundreds of wire pairs in his lap. In this situation he has no indication that any of the wires carries a dangerous voltage.

B) Signal Levels

In the trans-Canada system signal levels have been selected to obtain the optimum balance between signal-to-noise ratio and system overload. (Figures 3 and 4 outline these relationships.) If cable is properly maintained the effect of high level signals will occur first, not as cross talk in local cables, but as overload of carrier systems and, as indicated in Figure 4, a marked increase in the probability of intelligible cross talk appearing in these carrier systems. Crosstalk in local cables will increase at the same rate as the interfering signal is increased i.e. if e_B of Figure 8 is doubled in value (increased 6 dB) the signal measured on Pair A will also double. In the carrier system represented by Figure 4, if the signal level exceeds the design level the probability of cross talk increases at a faster than linear rate. For example if a signal level is doubled (above the designed limit) the probability of cross talk increases not by a factor of 2 but rather of a factor of 4 to 8 depending on the design of the particular system.

There is another difference between cross talk in cables and cross talk caused on carrier systems. The signal received in the cable as cross talk will be the high level interfering signal. The signal received as cross talk in the situation represented by figure 4 will usually not be the high level signal but will be one of the other signals being carried on the carrier system at the same time. In the latter instance, since the cross talk heard by a listener is not the signal causing the cross talk to occur, the problem of tracing the trouble becomes extremely difficult, especially so since the problem may be detected as a problem thousands of miles from its source (this can come about since the carrier system is only one entity of the over all system described in figure 2).

For these reasons the level of energy on voice frequency circuits in the range from 300 to 3000 Hz has been set at the average level of -12 dBm0 at the local central office as indicated in Section 2 A).

The presently used ringing signal of 20 Hz at 40 to 105 volts would appear at first glance to violate the requirements of signal level. However, this signal is sent only from the local central office to the terminal at the subscribers premises and is never sent in the opposite direction towards the toll centre and the carrier system. On local loop plant the level of 100 volts represents +40 dBm. As mentioned in the preceding section on Cable Balance, cross talk coupling is normally of the order of -100 dB. The crosstalk level can be calculated as follows:

Ringing Signal	+40 dBm (max)
Cross talk coupling	-<u>100 dB</u>
Cross talk level	-60 dBm

(The signal the calling party hears as "ringing" is not 20 Hz energy but a lower level, higher frequency signal to indicate the application of 20 Hz to the called terminal).

From the point of view of listeners the telephone instrument greatly attenuates energy coupled to the ear at these very low frequencies (see reference 6) and in addition the human ear is also much less sensitive (see pages 398 to 401 of reference 10). Data transmission is also insensitive to energy at these low frequencies.

Noise

As with most parameters the noise level objectives are based on economics where the risk of customer dissatisfaction must be weighed against the cost of control. Surveys represented by information such as figure 5 are used to define measurable values of noise against which existing plant can be evaluated and maintained and new plant can be designed. The overall objective of message circuit noise is to have the quality of service in the range of good or better on 99% of all short connections and on 90% of the longest connections (see reference 11).

It must be mentioned here that even slight longitudinal unbalance of the terminal, as discussed in the section on cable balance, can produce noise levels greatly in excess of this objective to the detriment of users on both ends of the circuit.

The noise so far discussed has been message circuit or continuous noise (hiss). Impulse noise also occurs, which, as the name implies, is caused by a sudden change in potential. Impulse noise is characterized by "Pops" in the telephone receiver and is typically generated by the opening or closing of a switch contact in an inductive or capacitive circuit, for example, interrupting the current in a relay winding. High levels of impulsive noise cause high error rates to appear on data circuits.

Impulse noise can be held to low levels by proper system design and maintenance. The generation of noise can be controlled at the source by maintenance of switch contacts and by adding suppression devices. Interference with other circuits can be reduced by providing good longitudinal balance, space separation and shielding. Even relatively simple electromechanical devices such as teleprinters pulsing on DC loops can cause impulsive interference to the circuits if not suitably designed and filtered. If these devices are operated unbalanced with one side of the loop grounded the level of impulse noise on adjacent circuits can be intolerably high.

C) Supervision and Signalling

Signalling and Supervision is the process by which the terminal and the central office indicate to one another what service is desired by a customer and how to provide that service. It is the means by which the terminal is informed that an incoming call is present, the means by which the local central office is informed that service is desired, what connections should be made through the network, and when the call is ended. Any errors or vagueness (marginal conditions)

in the signals interchanged can and will result in failure to perform the desired functions. There are three entities in this chain of command, viz, the terminal, the subscriber's loop, and the local central office, and the characteristics of each of the other two must be considered in a discussion or design of the parameters of any one.

Supervision

Supervision is the process by which the local central office can detect if the terminal is calling for service, or has completed a call. It is the proper functioning of supervision which enables a customer to indicate his desire to place a call and enables the communicating system to automatically record and time that call when required for charging. When the terminal is on hook (i.e. idle) the loop should appear as an open circuit to the central office. When the terminal is off hook (i.e. in use) the central office should see a loop whose far end is shunted by a resistance of about 200 ohms. If the current flowing in the loop exceeds a certain minimum (which is a function of the particular kind of central office in use) the office will reliably detect this and provide dial tone or whatever else it is supposed to do at that particular point in time. If an improper condition exists such as too great resistance in the terminal at the end of a limiting loop, the office may or may not detect the condition and the risk of unreliable service greatly increases.

At the end of use the terminal must again open the circuit at the end of the loop which will cause the current in the loop to drop below about 1 ma and the central office will detect this as an on hook signal. Although the loop conductors in the cables are insulated from one another and from ground, no insulation is perfect, and therefore some leakage will occur. Since it is a costly process to repair cables every time slight leakage can be detected the central office equipment is designed to accommodate a certain amount of leakage based on the premise that the leakage at the terminal will be nil. Here again the degree of risk and the amount of control required has been balanced to provide the best economical system.

It is interesting to note at this point that newer designs of central office permit supervision over longer loops. For example, step by step offices only permit loops of resistance up to 1300 ohms, #5 crossbar central offices limit the loop resistance to 1500 ohms and electronic switching offices permit a loop resistance to 1700 ohms. Today in Bell Canada there are about 630 entities of step-by-step serving 2.5 million lines, 360 entities of #5 crossbar with almost 1.1 million lines and 6 new electronic switching offices serving about 70,000. Future plans call for gradual replacement of step-by-step by electronic switching offices. Subsequently digital switching will be introduced to complement digital carrier systems.

Signalling

Signalling is the process of indicating to the central office what is required, as by dialing, or of the central office indicating to the terminal what is desired, as by ringing. Although signalling and supervision are similar in some ways they differ in that supervision tells the central office when the system is required and when it is no longer required while signalling indicates to the central office or the terminal what is required. Signalling involves function per unit time whereas supervision does not.

The ringing signal has been discussed previously. It is commonly a 20 Hz alternating current signal used to inform the terminal of an incoming call and, in some services, to cause the terminal to automatically answer that call and go off hook. Other forms of signalling can be used for this purpose, such as specific frequency tone signals at much lower levels, and are expected to be used in the future, (probably beginning within the next 10 years) increasing as economics permit. Although it has been shown that the present high voltage ringing signal is not hazardous to the life of the craftsmen, it can be uncomfortable to encounter. Also, it cannot be used for signalling through the network because of its high level and low frequency and is not compatible with solid state switching. For these and other reasons it is considered a candidate for change as soon as economics permit.

The other signalling function is that familiarly known as dialing in which the user indicates to the central office the electronic address of the terminal to which he wishes to be connected. The majority of loops in Canada are arranged for dial pulsing where the address is indicated by a series of pulses of current caused by interrupting the loop current at the terminal. A newer system, known as Touch Tone has been introduced and is being made available to increasingly large numbers of customers. Touch Tone uses combinations of two tones to indicate the numbers of the address.

Dial pulses are most commonly generated by what is known as a rotary dial. This device is designed to open and close a contact in series with the loop at a precisely controlled rate and for a precisely controlled time. Figure 11 indicates the open and closed condition of the dial contacts and shows the idealized current wave form through these contacts. The opened or Break interval is t_o. The closed or Make interval between two open pulses in a pulse train is t_c. $T = t_o + t_c$. The interdigital interval is t_i. The two parameters which must be closely controlled within the dial are the number of pulses per second given by $1/T$ and the percent break by $t_o/T \times 100$.

At the central office the dial pulse receiver must recognize the trains of pulses and act upon them. By counting the number of pulses in a given train it recognizes the digit that was dialed (5 pulses for the digit five for example) and recognizes the end of one digit and the beginning of the next by the interdigital intervals t_i.

All pulse receivers in the step-by-step offices must directly and reliably actuate step-by-step rotary switches. The rate at which these switches operate obviously sets the maximum number of pulses per second for the system. The lowest number of pulses per second is set by the need to differentiate between the length of the Make interval, t_c, and the interdigital interval t_i. There must obviously be some margin beyond each of these limits and there is.

The loop, as we saw in the discussion of cable balance contains an appreciable shunt capacitance per mile. In addition, it often contains series inductance to improve its high frequency response (this is known as loading) and, of course, series resistance. These three parameters combine to add distortion to the clean pulses of figure 11 so that the edges of the pulses become rounded and more difficult to detect reliably.

Based on these considerations rotary dials are designed to the following specifications. New dials must operate between 9.5 and 10.5 PPS and 58 to 64% break. Repaired dials must operate between 9.0 and 10.8 PPS. In-service dials may vary between 8.0 and 11.0 PPS. Excursions of the percent break or the in-service pulse rate beyond these limits will result in dialing errors, wrong numbers and retries to the annoyance of the user, and if wide spread, can result in a markedly greater equipment usage than was predicted by the theories of probability and risk which were based on these limits.

Touch Tone Signalling

The Touch Tone concept, first introduced in 1962, provides a more convenient and considerably faster method of signalling than the older dial pulsing. As shown in figures 12a and b there are two groups of 4 tones each used in this process and each digit must contain 1 and only 1 of the frequencies in Group A and one and only one of the frequencies in Group B. (Although the B frequency of 1633 Hz is not used in the standard dialing unit, it was provided in the Touch Tone planning so that it would be available for future use. It has been used in some special purpose systems.)

It is obvious that a signal produced by the Touch Tone unit has some self checking features. For example if the local central office receives more or less than one frequency from each group the digit is not a legitimate digit. Pushing two buttons at once will fail one of the two required tones and the central office will not act, thereby preventing wrong numbers.

A central office used with Touch Tone must have a Touch Tone receiver. One of the advantages of Touch Tone is that the loop distortion which limits the distance of dial pulsing does not have any great effect on the Touch Tone signals. In fact Touch Tone signals can be transmitted from end to end through the network (end to end signalling) without difficulty. However the Touch Tone unit in the terminal and the Touch Tone receiver in the central office must still be designed to compliment one another, and those characteristics of the loop which do effect Touch Tone signals and Touch Tone dialing must be considered.

Fig 12 shows the variation of power output with frequency which helps to compensate for the greater signal loss at higher frequencies and also shows how the power output varies with loop current, being greater for low currents which are encountered on longer loops with higher loss. These latter considerations minimize the range of signal power which the central office receivers can expect. The frequencies from the Touch Tone unit at the terminal must be kept to a tolerance of plus or minus 1.5% and extraneous signals must be at least 20 decibels below the total signal power. These tolerances apply over a temperature range of -30° C to +55° C and include not only manufacturing variations but also in service limits. Here again is an example of the various entities being designed to complement one another.

In Section 3 B) it was indicated that the average signal power at the central office should not exceed -12 dBm0. From Fig 12B and typical loop and central office losses it can be calculated that the average power from a touch tone unit at the central office will be about -6 dBm0. However, on the average the ratio of the time the tone is on to the time it is off during dialing will be less than 25%, and this means that the average power is therefore less than -12 dBm0.

The arrangement of the keys in Fig 12A was arrived at after many subjective tests were performed with different numerical arrangements. It resembles, but is not identical to, the numerical arrangement of an adding machine. The arrangement adopted was the one which resulted in the fewest wrong numbers being presented to the system by the users. (It is interesting to note that many of the newer calculating machines are now adopting this same arrangement in preference to their earlier one.) The least significant digits are at the top of the dial while the most significant is at the bottom (0 is always used to denote 10).

Attention was also paid to the button design with respect to resistance and distance of travel to minimize errors by requiring a full key depression which assures signals will last for at least 40 ms so that the receiver at the central office will have sufficient time to respond. All of these parameters have been based on the research-development-experience cycle.

It should be noted here that while #5 crossbar and electronic central offices can be readily equipped with Touch Tone receivers, the older step-by-step offices would be very expensive to convert. As these older offices are gradually replaced with newer ones in the normal course of events the replacing ones will be equipped with Touch Tone.

Section 4

Interconnection of System

As we saw from figure 2 and the discussion of Sections 2 and 3 each of the entities in the Canadian Telecommunication System has been designed to complement the others in order to arrive at a grade of service whose parameters of transmission quality (such as noise level, signal-to-noise ratio, bandwidth, etc) and signalling and supervisory sub-systems all fit together to provide the grade of service which many preference tests with groups of people have shown the subscriber really wants. The North American Telephone System (Canada and the United States) is considered to be the best in the world. In the Trans-Canada Telephone System the parameters we have been discussing have been carefully chosen and rigidly adhered to in the design and maintenance of the overall system. Close watch is kept to detect any sign of potential or actual deterioration from these standards in order that remedial steps can be taken before a serious deterioration occurs. To avoid catastrophic problems the switching system has a wide range of alternate routings to chose from, as indicated in Figure 1, long haul microwave systems have standby channels and automatic switching to them in case of failure of a working channel, etc. We have seen how every entity of this system affects all the others.

If, to a system designed to meet certain limits of noise, bandwidth, distortion, and so forth, we attach, in tandem another system designed to meet the same limits, then it is well known to any system designer that the new overall system will fail to meet the limits of the original systems. Simply put, no transmission medium can produce at its output any better signal than that which was presented at the input, and in a real system there is always some deterioration of the presented signal.

If two or more systems are to become sub-systems of a larger system, then, as we have seen, each of the sub-systems must be designed so that the desired overall quality is met, which means the sub-systems must be designed to a higher standard.

The members of TCTS offer to their customers Private Branch Exchange (PBX) service. In order to meet the overall objectives of the Telecommunication System, loops feeding these PBX's from the central office are not permitted to have either as high a resistance or as great a loss as those feeding individual terminals. This assures that the terminals connected to the PBX will be assured of a good grade of service when they connect through the PBX through the larger network. The standards, however, to which the PBX is designed are equally as high as those to which the network is designed. Reliability is high and maintenance must be of a suitable calibre and frequency or the PBX could cause the same troubles of supervision and signalling to and from the central office that were discussed in Section 3.

The design of a communicating system requires a thorough knowledge of the various parts of the system, including the terminal, and the often subtle interactions between these various parts. Because of the changes that are continually being made to the TCT System and because of the inter-action between the various parts of this system it is imperative that the members of the system retain full control over the system. Without this control the member companies would certainly be impeded in making economical technological changes in many instances and could be prevented from doing so in others because customer owned inter-connected systems might not be able to accommodate these changes. Two such changes which are expected to occur within the next 10 years or so have already been mentioned, viz, digital systems and a trend away from 20 Hz ringing. A customer with a connected system, as is human nature, would be very loath to replace portions of his satisfactorily operating system because a member of the TCTS found it economic to change from analogue loop distribution plant to digital or wide band technologies. The same reluctance would occur to the change from 20 Hz ringing. Again, if economics and technology permit, Touch Tone signalling will become very common and the dial pulse systems will disappear - at this point in time new central offices will no longer be designed to accept dial pulse signals and a customer's system, which depends on inputting them would be unworkable.

Certain restricted inter-connection with customer owned systems such as paging systems, could be workable where the communication requirement is of the "in-house" type, and does not involve "anywhere to anywhere" network connection. In this situation, since PBX systems provided by members of the TCTS are designed and maintained to be part of the network system, their parameters are not limiting. Since the customer-owned paging system would not have access to the public address network it would not be in tandem with a limiting system and transmission quality could be maintained. Also the network would not be affected. Where such interconnection is logical and reasonable (considering technical requirements, risks, necessary control) it could be considered subject to suitable agreements concerning parameters, controls, and maintenance.

Section 5

Interconnection of Common Carriers

Common carriers have as a primary technical objective the intent to protect and improve the telecommunication environment for the benefit of all users. Since the carriers sell service, maintenance of service is of paramount importance and the appropriate plant personnel are trained accordingly. Usually the primary systems and important services are maintained on a round-the-clock basis while services of lesser importance are maintained on a daily basis or as required. Interconnection among Common Carriers jointly providing a service, for example members of the TCTS, has been carried on for many years by agreement between the parties and with a minimum of difficulty or disruption. These points of interconnection are carefully specified as to location and characteristics and the parties have both a prime interest and the ability to meet and maintain these agreements. Over the years the Telephone Companies in Canada and in North America have developed technical, administrative and operational standards, procedures and practices which ensure effective interworking of the systems to the advantage of the public community.

Other existing carriers have evolved their own techniques and administrative procedures which are well suited to their particular needs. Where these are significantly different (for good reason) maintenance and system design problems are created when the systems are interconnected.

Limited or special purpose carriers, such as the telecommunications arm of the Hydro companies may have standards and service requirements which are significantly different, either higher or lower than those of Common Carriers, and in this case also significant interconnection problems can be expected.

Section 6

Connection of Terminals

Connection of common carrier facilities and customer owned terminals is an area which to many users appears to offer a lower cost alternative to services offered by the common carriers or offers services not offered by the common carriers. As we have seen in Sections 2 and 3, it also offers the potential for serious harm not only to certain elements of common carrier hardware but also to the use by others of the public address network. Since the common carriers could exert little if any influence on the design, usage, and above all maintenance of customer owned terminals they are very concerned about the consequences of interconnection.

The common carriers are continually applying effort to improve the quality of service (eg. reduce noise and attenuation, increase reliability, reduce costs, etc.) provided to their customers. This is an ongoing activity which must continue if the public is to be well served in an era of rapidly changing technology. When the carrier owns all parts of the system a natural overall information "feedback" path exists which often serves to highlight areas requiring improvement. If ownership is split, as with customer provided equipment, this feedback path is broken and identification of problem areas is made more difficult.

From the point of view of the buyer the requirement is to obtain the desired function for a minimum cost, and his shopping is usually based on the comparison of first cost or purchase cost of the hardware available from different manufacturers, since he is often in no position to compare maintenance and operating expense. In this competitive market the manufacturer must attempt to build hardware at minimum cost and this may reduce incentive on his part to put major emphasis on the characteristics of stability, reliability, maintainability, compatibility with requirements of the network, which are of paramount importance to the common carrier.

As Sections 2 and 3 have shown, the public address network and private line facilities are built up of the same entities as shown in Figure 2, the only difference being the absence of switching and the individual design in the private line case. In both situations, since the individual entities have a probabilistic nature, the overall facility will also have a probabilistic nature (i.e. any given parameter can be expected to vary by some amount from its mean value for all such circuits taken together). The unsophisticated buyer of terminal hardware, unfamiliar with, or even unaware of the existance of, these variations (and not interested in them since communications is only incidental to his business and not his prime purpose) can well be misled by manufacturers.

The statement "hardware designers are typically ingenious - system designers must take a long view" applies very well here. The system designer must consider each aspect of his work in terms of its overall effect on the system, the service to be provided and the economic and technical trade-off over the long term. This statement summarizes the fundamental difference of purpose between the terminal equipment supplier and user on the one hand and the communication supplier on the other - the first is interested in providing a specific function for himself, while the latter is interested in providing and maintaining a specified grade of service to all users.

If customer owned and maintained terminals were to be connected directly to the facilities of the Telecommunications systems there is one major parameter that a customer might be strongly tempted to violate. This violation would be of the level of signal power applied to the system because a lower error rate in voice or data services can almost always be achieved by obtaining a greater signal-to noise ratio and a greater signal-to noise ratio, for a given level of noise, can be achieved by raising the sending level. In addition he may inadvertently, because of lack of knowledge, lack of interest, or lack of maintenance, violate others to the detriment of the overall Telecommunications system.

Sections 2 and 3 describe the local cable crosstalk, and the more serious and insidious intermodulation crosstalk due to carrier overload. Since the customer's prime interest is his own communication, and since his operations are not affected by so doing, the temptation to raise his sending levels is not balanced by any adverse effects that he can detect. As indicated in Fig 4 and discussed in Section 3, very little increase above the -12dBm0 average level can rapidly increase the probability of intelligible crosstalk in the carrier system. This sort of interference or overload can be tracked down, with considerable difficulty, on dedicated private line facilities, but because of the probabilistic nature of the switching function of the network, as intimated in Figure 1 and discussed in Sections 1 and 2, this type of overload is almost impossible to find on the public address network.

With respect to the signalling and control functions described in Section 3 similar problems arise. Failure of a signal mechanism such as a dial to consistently adhere to the requirements of Section 3 will result in mis-dials and wrong numbers. The consequent annoyance to the wrongly called parties, the requirement on the part of the Telecommunications system to manually rebate the accounting for mis-dialled long distance calls, and the increased use of the central office as the user tries again all represent undesired situations to the detriment and expense of other users of the network.

Failure or marginal operation of supervisory signals can result in such things as the office failing to go on-hook at the end of the call or a complaint from the user that the office fails to go off-hook and provide dial tone at the beginning of a call, both of which involve plant effort and expense to find the cause of the trouble.

The intent of the preceding discussion has been to indicate the potential problems inherent in terminal equipment from the point of view of adverse effects on the total Telecommunications system and its other users. Defects and troubles in customer provided terminal equipment which would affect only the customer himself, i.e. failure of a data set to transmit data, will not be discussed. An example of the magnitude of the problem is indicated by the fact that Bell Canada, which operates a total of 5.5 million telephones adjusts or replaces about 0.3 million rotary dials annually because of failure to meet the requirements specified in Section 3. These dials are designed and built to rigid standards, and still require regular maintenance.

Type Approval

From time to time the proposal has been heard that customer owned hardware should be permitted to interconnect with the facilities of the Telecommunications Companies provided it meets some sort of type approval which would assure compliance with the requirements of, and compatibility with the facilities of the communications suppliers. After all, electrical apparatus must meet the tests of the Canadian Standards Association Laboratories and be stamped with their type approval numbers before it can be placed into service or even be offered for sale! Type approval for use of equipment on the public address network or private line service and type approval for use on electrical power circuits appears, at first glance, to be essentially the same sort of problem.

In reality the problems are quite different. The purpose of CSA approval is to assure that, when offered for sale, a given device presents a minimum electrical hazard to the user. It does not assure that the hardware inspected will perform the function the purchaser desires. The approval is based on tests made at a given point in time on typical production units provided by the manufacturer to the testing laboratory. It does not guarantee that the hardware will not be modified or changed by the user of the hardware. Changes or modifications by the user can unknowingly invalidate the CSA approval and can result in (a) failure of the apparatus to perform the task for which it was designed, (b) fire on the premises of the user, (c) operation of a protective device to disconnect electrical service to the user, (d) hazard to the person of the user, or some combination of these. None of these four conditions is likely to affect any one but the user himself within his own premises.

Type approval of terminal devices for communications purposes indeed has some similarities to the CSA situation, viz a testing authority, parameters which must be tested for, a procedure to be followed by a manufacturer in order to obtain approval, and a procedure for indicating and listing those items which have obtained approval. However, since faults can occur after approval due to normal use which can adversely affect the communications network and other customers' usage, an initial approval of hardware at a given point in time is obviously not sufficient. In addition, consideration has to be given to maintenance and how to assure that it will be carried out and also a means to detect when the device is faulty for as we have seen terminal hardware may still perform quite adequately a function that the user desires while at the same time adversely affecting the network and the service of other customers.

A question that must be asked of any proposal for type approval is "how does one accommodate technological advances in the common carriers' communication system". It has been pointed out for example that the common carrier's expect a trend away from the 20 Hz rigning signal within the next 10 years and also a much greater usage of digital plant. Type approval parameters based on today's plant requirements would obviously inhibit these changes just as type approval instituted, say, 20 years ago, would have tended to inhibit the quality and variety of services available to the users today.

In the power distribution system purposeful or accidental faults or deficiencies usually affect only the user or at most have a local perturbing effect. This comes about because the user only receives energy from the network. In the telecommunication system, however, not only does the user receive energy from the system, he inputs to it and interchanges control signals with it. It is this fundamental difference between the power and telecommunication systems which makes type approval useful for the one and very risky for the other unless and until effective control of the end-to-end system design and maintenance can be assured at no cost to other users.

Used Equipment

Up to this point, the discussion has been concerned with new customer provided equipment and its potential problems. There are advertisements in the popular press offering used telephone equipment for sale. In the business machine field, there are a number of purveyors of used equipment. Since these equipments have been removed from service for some reason, their present condition and their ability to meet the original design requirements are both open to questions. There is no present practicable means to interconnect with used equipment at low risk except via protective connecting devices.

Connecting Devices

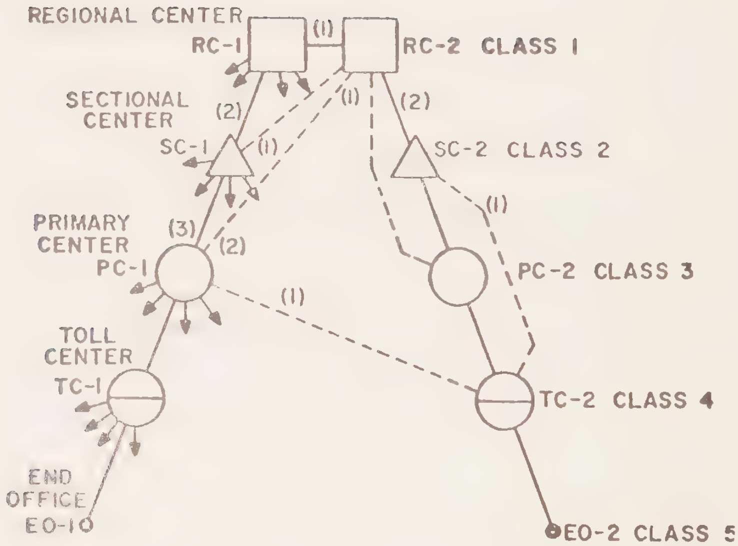
Where a useful purpose can be served to do so, devices can be designed and built by the telecommunications suppliers which will terminate their facilities on the user's premises, permit his hardware to interface via these devices with the network, and at the same time greatly reduce the risk of operational and economic damage to other users of the system. These devices would be designed to be fully compatible with the signalling and supervisory systems currently in use, would present to the user a common and consistent interface, would prevent either by malfunction or intent on the part of the user and his equipment any overload to the network to the detriment of others, and would be part of the economic consideration of the TCTS in planning technological change to the advantage of the network. These devices would be owned by the common carrier and would provide the necessary technological control it requires to continue to operate and administer the present and future networks to the advantage of all users. It must be emphasized here that such devices would not guarantee the successful operation of customer owned apparatus connected to them but would only assure that no disruption of the public address network or private line services occured.

Previous submissions under study 8 b 111 include details of the connecting devices and applicable rates as provided by the TCTS companies.

Table 1

Probability that N or more links will be required to complete a toll call.

No. of Intermediate Links, N	Probability	
	Fig. 1	Bell System Data
Exactly 1	0	0.8
2 or more	1.0	0.2
Exactly 2	0.9	-
3 or more	0.1	0.03
4 or more	0.1	0.003
5 or more	0.010, 9	-
6 or more	0.001, 09	-
Exactly 7	0.000, 01	0.000, 03

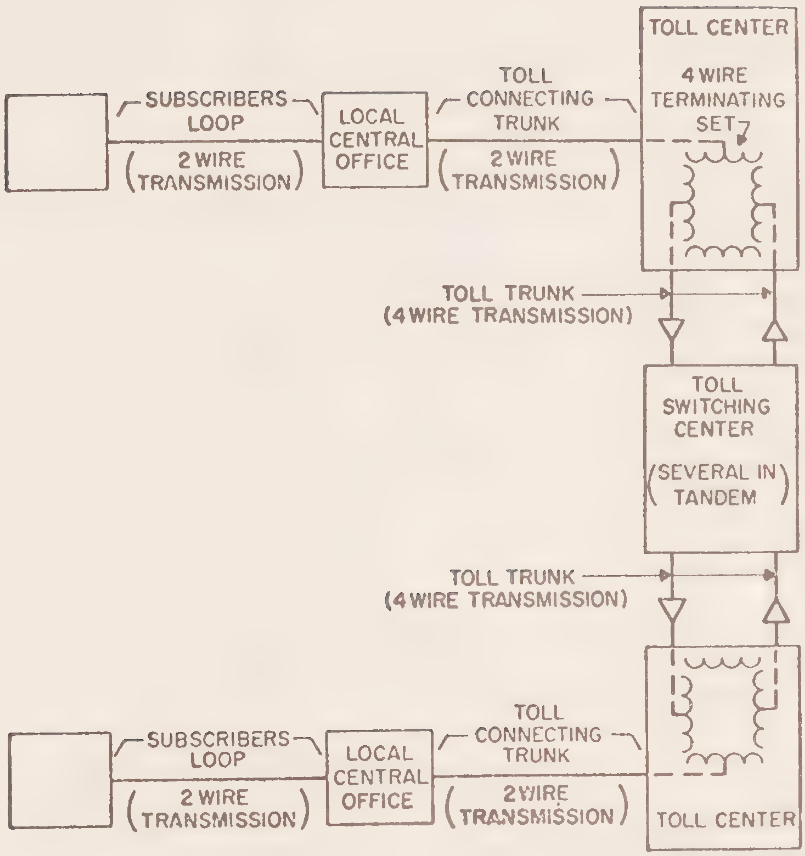


NOTES:

1. NUMBERS IN ( ) INDICATE ORDER OF CHOICE OF ROUTE AT EACH CENTER.
2. ARROWS FROM A CENTER INDICATE TRUNK GROUPS TO OTHER LOWER RANK CENTERS THAT HOME ON IT. (OMITTED IN RIGHT-HAND CHAIN)

Illustration Of Choice Of Routes On Assumed Call

Figure 1



Inter-City Subscriber To Subscriber Connection

Figure 2

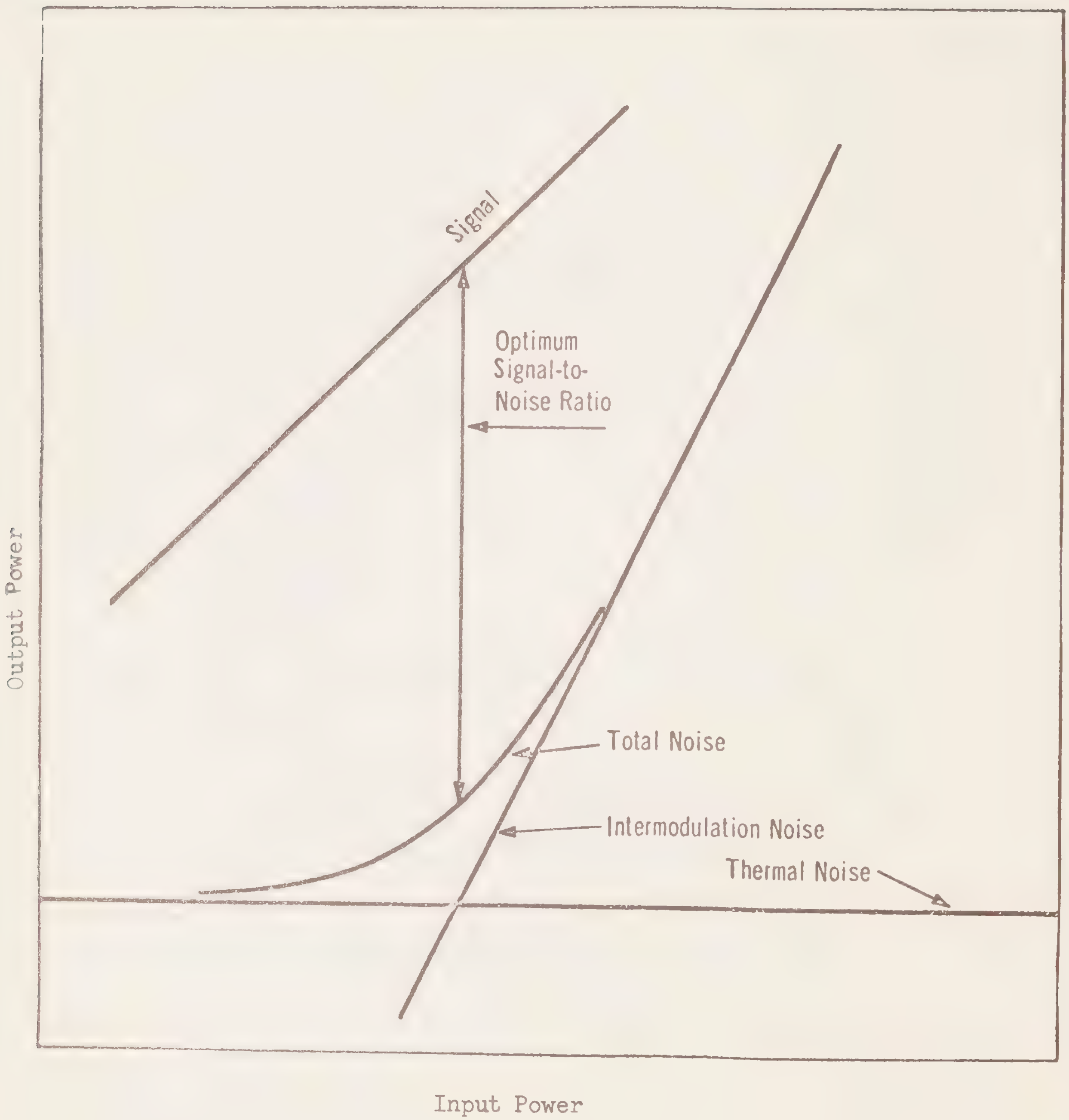


Figure 3 - Relationship Between Signal and Noise Power For Second Order Distortion Limited System.

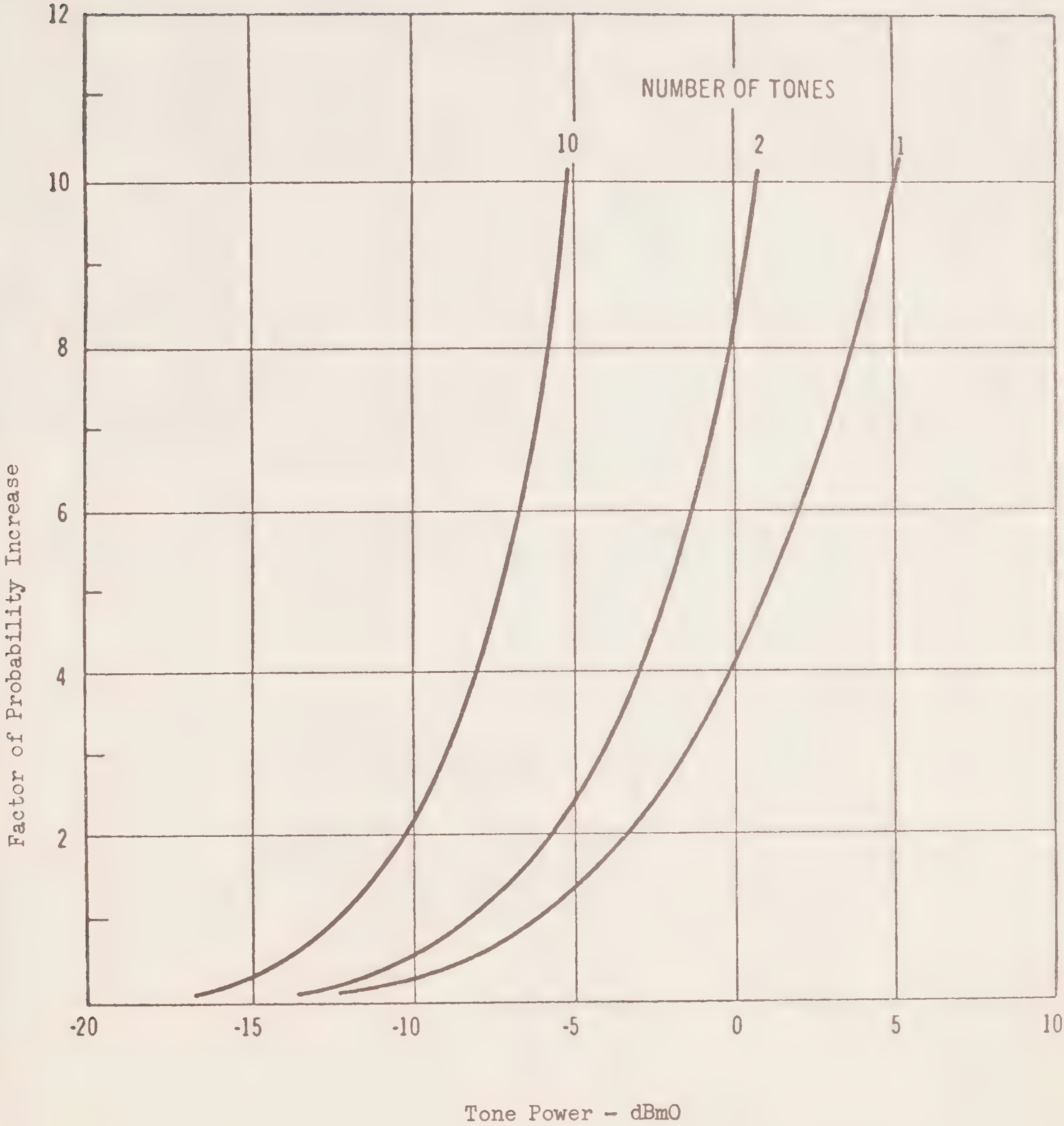
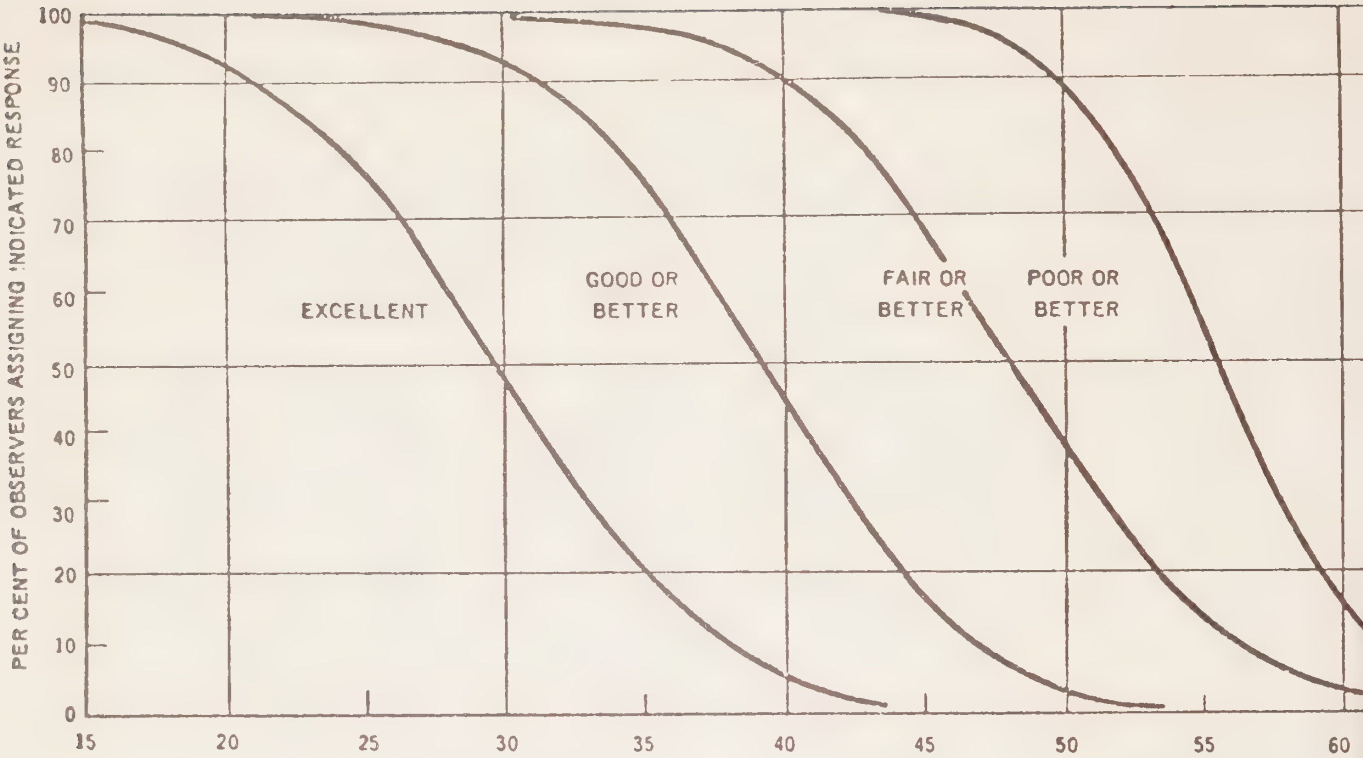


Figure 4 - Probability of Intelligible Crosstalk
As a Function of Single Frequency
Tone Power.

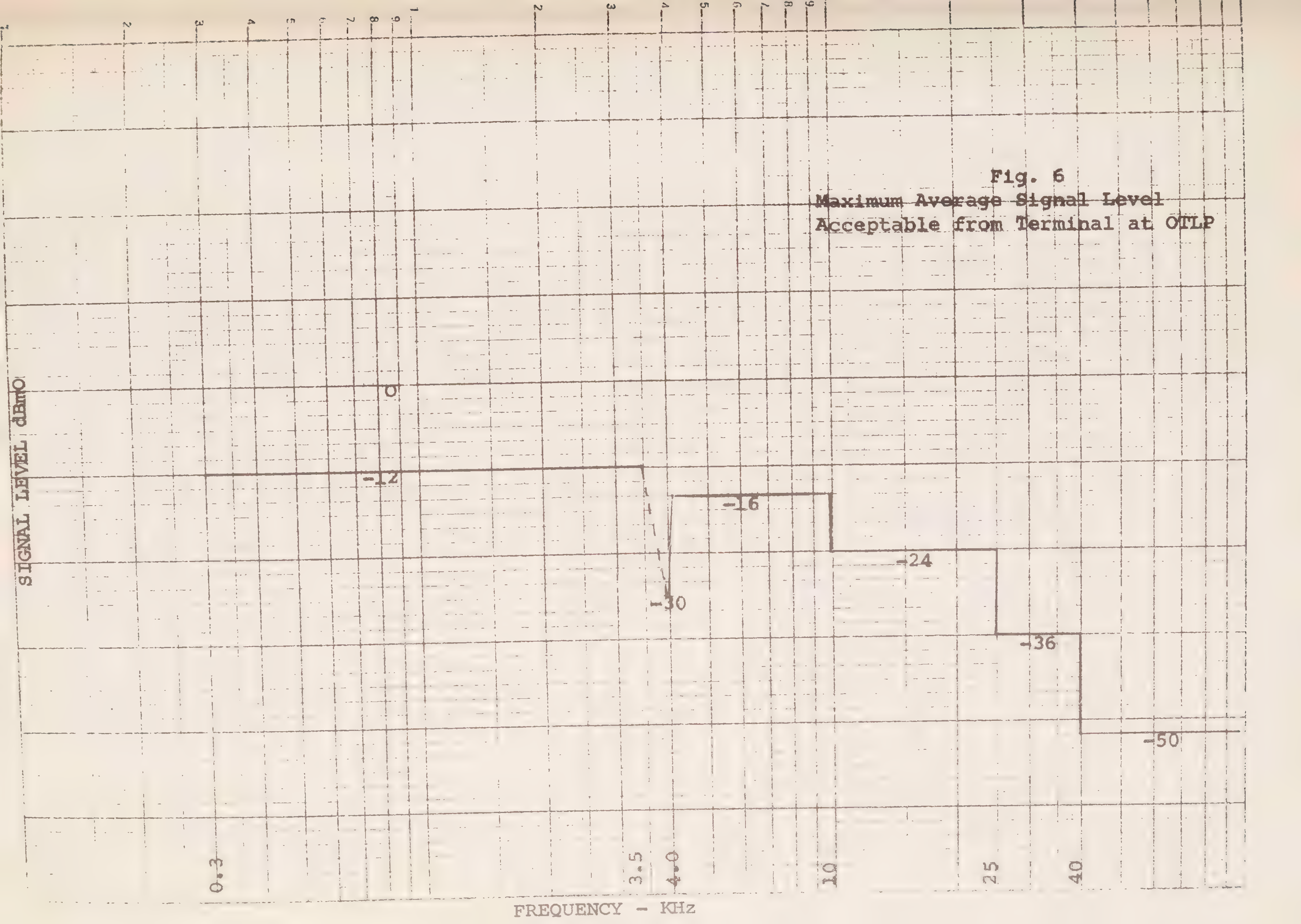


Noise Level at Line Connections of Station Terminal in dBrnC

* For an explanation of dBrnC, see Reference 1, page 21.

Figure 5 - Subjective Appraisal of Noise Measured At the Station Set.

Fig. 6
Maximum Average Signal Level
Acceptable from Terminal at OTLP



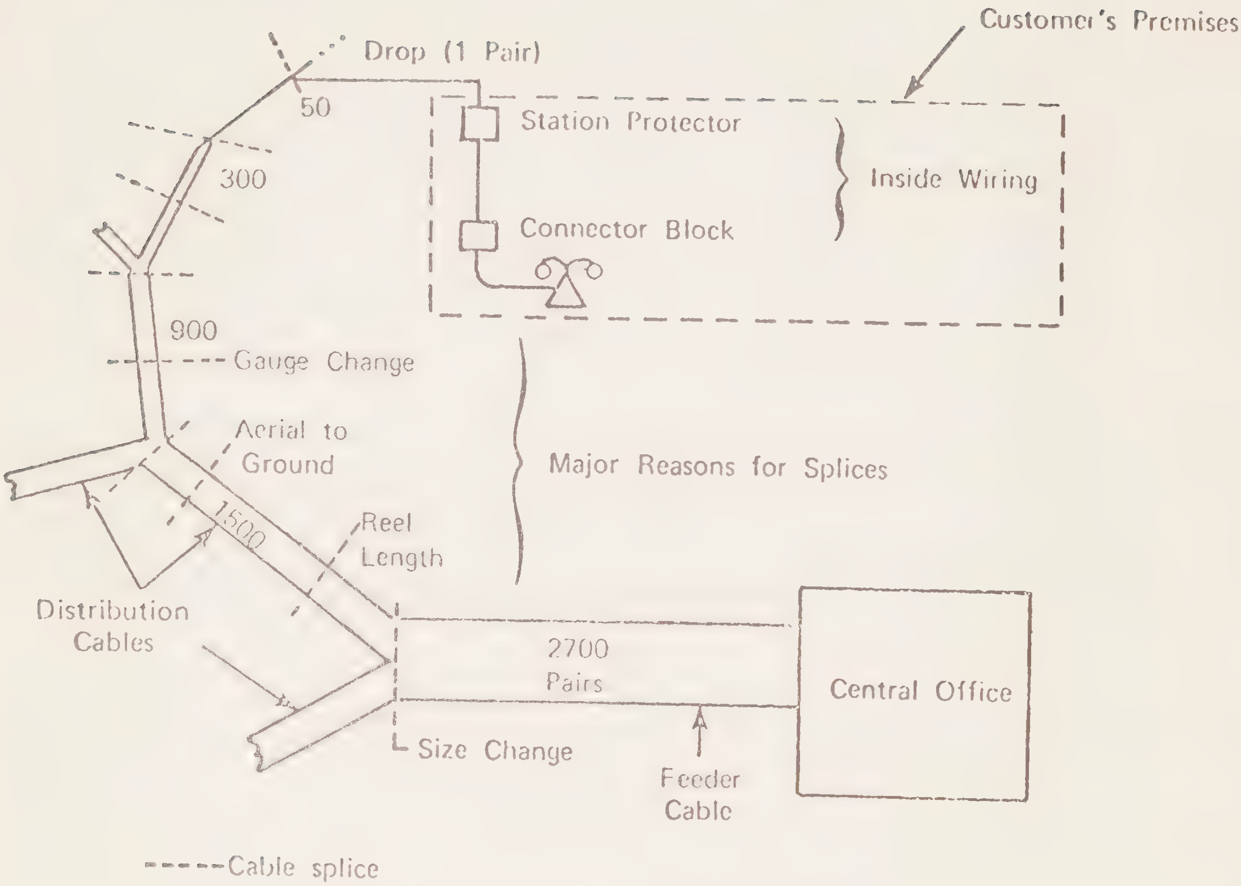


Figure 7 - Typical Loop Plant Layout

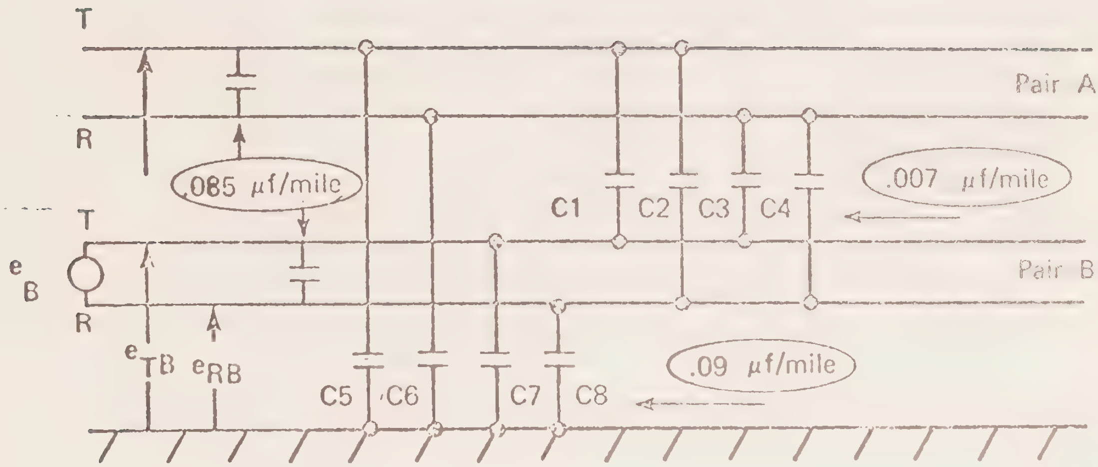
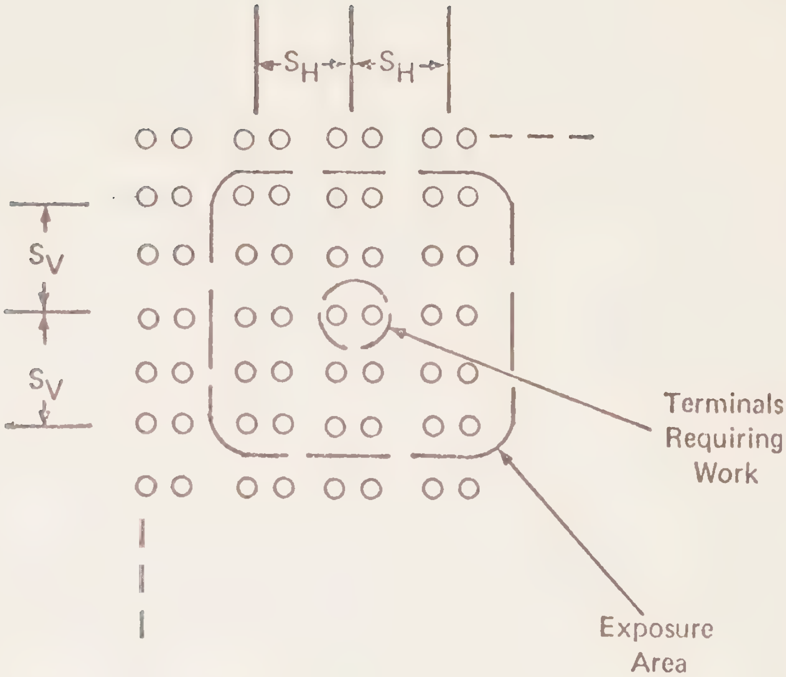


Figure 8 - Simplified Diagram Showing Interaction Paths between Two Pairs in a Cable.



S_H = Horizontal Exposure Span

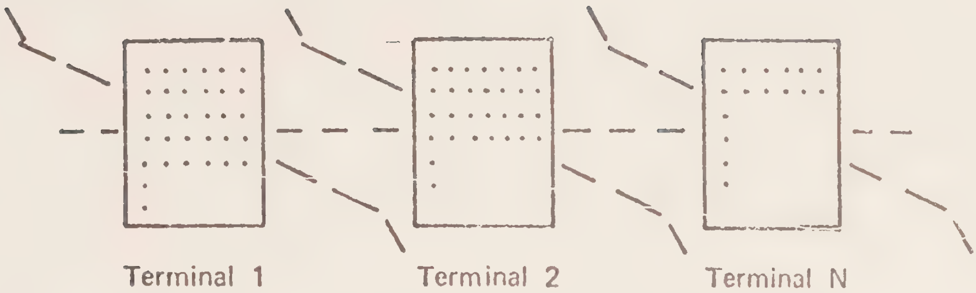
S_V = Vertical Exposure Span

E_E = Exposure Enhancement Ratio

$E_E = (2\ S_H + 1)\ (2\ S_V + 1)$

(Numerical Example) –
Assume (Per Sketch): $S_H = 1$; $S_V = 2$
Then: $\underline{E_E = 15}$

Figure 9 - Terminal Configuration.



$E_{E_1}, E_{E_2} \ldots E_{E_N}$ Are Exposure Enhancement Ratios for Terminals, 1, 2, . . . N, Respectively

(ΣE_E) = Overall Exposure Enhancement Ratio

Upper Bound on (ΣE_E) with no correlation of Wires in Terminals

$$(\Sigma E_E) \leq E_{E_1} + E_{E_2} + \ldots E_{E_N}$$

Reasonable Lower Bound on (ΣE_E) with Correlation

$$(\Sigma E_E) \geq \sqrt{E_{E_1}^{\ 2} + E_{E_2}^{\ 2} + \ldots E_{E_N}^{\ 2}}$$

(Numerical Example) –

Assume: Work on 4 Terminal fields per job.

$$E_{E_1} = E_{E_2} = E_{E_3} = E_{E_4} = 15 \quad \text{(Per Fig. 1)}$$

Then: $\underline{30 < (\Sigma E_E) < 60}$

Figure 10 - Overall Exposure Enhancement.

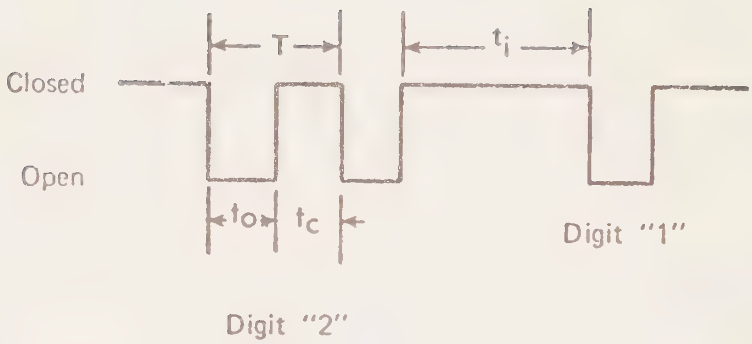


FIGURE PARAMETERS OF DIAL PULSE SIGNALING

Figure 11 - Parameters of Dial Pulse Signaling.

Fig. 12a Touch Tone Dial Unit

Tone Group	Touch-Tone Frequency (Hz)	Line Current 20 ma	75 ma	150 ma
A	697	-3.5 dBm	-7.8 dBm	-10.5 dBm
	770	-3.0	-7.3	-10.0
	852	-2.8	-7.1	- 9.8
	941	-2.5	-6.8	- 9.5
B	1209	-0.7	-5.0	- 7.7
	1336	-0.6	-4.9	- 7.6
	1477	-0.5	-4.8	- 7.5
	1633	-0.4	-4.7	- 7.4

Fig. 12b Typical Output Power of Touch-Tone Unit in dBm into 900 ohm Load.

BIBLIOGRAPHY

Bell Canada - Memorandum on Research and Development Exhibit No. B-66, April 1969.

Bell Canada - Memorandum on Innovation and Modernization, Exhibit No. B-71, 1969

Telecommission Study 4 (a), The Future of Communications Technology.

Statement of Thomas F. McMains Regarding Western Union Policy as to Customer-Provided Terminals in TWX Service.

F.C.C. Docket No 18519, Western Union Exhibit #3

Report of the Telephone and Telegraph Committees of the Federal Communications Commission on the Domestic Telegraph Investigation - Docket No. 14650, April 29, 1966.

Stanford Research Institute, Report Nos. 7379B-1, -2, -3, -4, prepared for F.C.C. Docket No. 16979 re Computer Inquiry.

Reports of the President's Task Force on COMMUNICATIONS TECHNOLOGY (Rostow Report) PB 184 412 parts 1 & 2
PB 184 417
PB 184 423
Final Report

Terminal incompatibilities in Data Communications Systems by John C. Tirrell, Telecommunications, Feb. 1970

A New Electronic Data Switching System for Data Communication, Reprint from Nachrichtentechnische Zeitschrift, 1969, No. 8, Pages 444 to 463, Authors Karlheinz Gosslau, Adolf Bacher et al.

TCTS Notes on Planning - submitted to the Hon. Eric Kierans, 13 January 69.

Studies within the U.K. on a Proposed Public Switched Data Network - An interim statement (April 1970) issued by G.P.O.

Data Traffic: The Communication of Digital Information - Reprint from Nachrichtentechnische Zeitschrift, Author Karlheinz Gosslau.

IEEE - 1970 International Convention Session 5B - Video Telephones, A New Way of Communicating

L'Evolution des Télécommunications et La Recherche, Etude perspective: Horizon 1985, Bruxuelles, Nov. 1969.

Bell System Technical Journal, May 1960, Capabilities of the telephone network for Data Transmission.

TELECOMMISSION

Study 8(b)(iii)

Problems Relating to the Interconnection of Terminal Devices with Common Carrier Provided Telecommunications

The Department of Communications

SECTION V111

STUDY 8(b) iii

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This Report was prepared for the Department of Communications by a project team made up of representatives from various organizations and does not necessarily represent the views of the Department or of the federal Government, and no commitment for future action should be inferred from the recommendations of the participants.

PROJECT TEAM

The Project Team consisted of the following representatives from departments of the federal government, from telecommunication carriers, and from associations and organizations of users. The appendix contains submissions received from these representatives.

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Canadian Electrical Association

Mr. M. Brodie
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Mr. W. A. Caton
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Mr. W.J. Wilson
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Although these members of the team contributed to the report and participated in its preparation, they do not necessarily agree to every statement made in it.

Since this study was one of three devoted to interconnection, the terms of the other studies were circulated through the three Project Teams; during the course of the studies appropriate information was shared as required, and discussions between Liaison Officers and members of the three Project Teams assisted in reducing any redundancy.

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CHAPTER 1

Introduction

Purpose of Study

The primary purpose of this study is to identify and examine the problem areas relating to the interconnection of user-owned or supplied communication terminal devices with services provided by the telecommunication carriers in Canada. The issues will be examined from three particular points of view:

1) that of the user
2) that of the manufacturer
3) that of the carrier

The subject of interconnection of telecommunication facilities of mixed ownership is one of several dealt with in Section 8 of the Telecommission studies.

In order to provide the appropriate focus on the issues involved in interconnection, the project was divided into three separate studies, of which this, relating to telecommunication terminals, was one. The other two sub-studies, 8(b) i and 8(b) ii, relate to interconnection of privately-owned telecommunication systems with those of the carriers, and the interconnection of carrier systems with each other, respectively.

Background of Study

The issues and problems arising from the interconnection of facilities owned by the carriers with terminal devices of mixed ownership are relatively new, and the majority concern interconnection with the switched network of the carriers rather than with their family of private-line services. Private-line services, in general, are not shared by users, and interconnection issues are negotiable. However, interconnection of terminals with the general switched networks can affect other users of the system as well as the integrity of the planning for the total system.

These issues seem to derive from two factors. The first is the rapid expansion of mechanized information handling systems employing computers and remote access terminals which has developed during the past ten years. The earlier development of communications in Canada was focused on the need for electronic voice communications and the expansion of the associated network to reach all parts of the country. As the growth in installations of data-processing equipment occurred, both in size and number, the electronic transmission of data became an

attractive method to transfer large quantities of information to and from computer centres.

The second factor that has raised issues of interconnection is the flood of new telecommunication terminals which have been developed by manufacturers utilizing various combinations of transmission speeds, machine languages or codes, media such as cards, tape, etc., and which have the capability of serving one or more information-handling functions.

Thus, when selecting a terminal the user has a very broad potential spectrum of choice, but his actual choice is limited to terminals that the carriers will allow to be interconnected with their facilities. Manufacturers feel that the carriers inhibit the development of the market for new communication terminals, for, in the absence of widely accepted technical and economic guidelines and standards, the carriers place limitations on the variety and extent to which users may employ communication terminals connected to their general telephone network. Though most of these practices are derived from or are incorporated into existing legislation and/or regulatory practices, the use and enforcement of these practices by the carriers tends to create the impression that they are the final arbiters in such interconnection. In actual fact, the majority of regulatory bodies have processes through which users may appeal any unfair or discriminatory application of interconnection practices.

All of these complications have created policy problems which involve the user, the manufacturer, and the carrier. All three agree that the user should be able to serve his need effectively, that the carrier must develop and maintain his network to provide the best possible service, and that the manufacturer should continue to develop new techniques and products, as well as to improve existing ones to serve the users' needs.

Scope and limitations of the Study

Any study of interconnection issues in telecommunications should preferably be preceded by a determination of the priority that interconnection policies have when referred to the total of national communication objectives. This question can be tested by determining whether interconnection issues would remain after objectives and policies had been established in such areas as the permitted amount of competition between carrier suppliers, the economics of developing and introducing products of Canadian research and manufacture versus those of foreign source, and the degree to which telecommunications capability is to be developed in Canada by other than the existing carriers.

There is general agreement by the participants in this study that if issues of this nature were resolved, there would be few residual interconnection problems. Thus, any attempt to deal

with interconnection issues cannot be seriously undertaken without making assumptions about the related and more important economic, commercial and technical issues involved. These related issues are being dealt with in other Telecommission studies.

The Project Team also recognized that a more rigorous examination of the detailed technical problems of interconnection than could be undertaken in this study should be the subject of further investigation.

Thus, the scope of this study has been carefully selected to examine the current specific issues relating to the interconnection of terminals with the facilities of the carriers, and has avoided any broad excursions into other areas. As terms of reference, the study set out to examine: -

1) the interconnection practices of the common carriers as they exist at present, and any possible future trends that can be anticipated;

2) the communications terminal field and its general classification, and any reference possible to the direction that technology in this field appears to be taking;

3) user requirements for terminals, including the variety of needs being served now and those that are foreseen in the immediate future;

4) manufacturers' objectives in the terminal market, and problems arising from interconnection practices that affect the development of this market;

5) special interconnection situations such as the use of multiplexors, interconnection of radio terminals and other special customer requirements;

6) any economic trends in the communications terminal field, particularly with their relationship to alternatives.

Re 2) above, during the course of the study, the Project Team concluded that a detailed examination of communication terminals would require much more time than was available and would not have any significant value.

Some of the submissions to this study undertook to define the various categories and functions that can be served by communication terminals, and since none of the problems arising required any further explanation or description, the Project TEAM AGREED TO FOREGO A MORE DETAILED EXAMINATION.

Definition

The term "telecommunications terminal" is one which covers a very broad area of technology, and which can be defined in a number of ways, depending upon the objective. From a technical angle, the term can refer to a single set of binding posts that terminate a communication channel, or it can refer to the very sophisticated complexion of the largest computer operating as a terminal on a carrier's network.

For purposes of this study, a terminal refers to a point in a telecommunication system where information may enter or leave the system, or where it may be stored until conditions permit the information to be moved to another terminal or terminals.

With respect to ownership of terminals, there are two classifications involved:-

1) user owned, and

2) user leased, from

a. terminal manufacturer or supplier
b. telecommunications carrier

Another means of classifying terminals used by the Project Team involved their function, and these seemed to fall into three main classes:-

1) terminals oriented to people -

to be used directly by humans, to hear, see, write or speak; this category includes telephones, typing machines, machines used to transmit writing or reproduction, etc.;

2) terminals oriented to other machines or systems -

such telecommunication terminals require input from machines and provide output only to machine, i.e. magnetic tape terminals, processors, accounting machines, all for on-line use, or terminals involving read-write in machine-oriented language. Neither the input nor output of such terminals can be interfaced directly with humans;

3) terminals that control, monitor and supervise communication facilities -

devices such as switchers, multiplexors, automatic dialers, voice operated

switches for radio terminals, etc.

Some terminals can serve more than one function, and the above classification was not intended to limit but rather to direct consideration to areas that are compatible with user needs.

CHAPTER 2
Interconnection Practices and Carrier Requirements

Historical Barkground

The recent emergence of problems resulting from interconnection practices of the telecommunication carriers might suggest that a new dimension is being added to telecommunications which must be dealt with quickly and effectively if further progress is to be realized. In actual fact, interconnection practices have existed almost as long as the communications industry itself and until recently have primarily affected only those carriers involved in the development and growth of the telecommunications network in North America.

In the early part of the century, there was a proliferation of telephone companies, each serving a community of interest and sometimes competitively, which were gradually interconnected to form the vast continental system now in existence. Due to the wide variety of technical standards among the independent companies, interconnection practices were established when any merger or integration occurred. In these circumstances the standards of the larger company usually prevailed.

As a result, interconnection practices have evolved over a long time and are still in the process of evolution. On an international basis, for instance, interconnection standards are continuously being derived to permit the development and expansion of an international network covering all occupied areas of the world.

This process of evolution, applied to interconnection practices in Canada, has now reached a point that affects the user of telecommunications individually, as well as the manufacturer of telecommunications equipment. It has created problems that interfere with the accomplishment of the users' objectives and requires that he use new, and sometimes unfamiliar, skills to deal with them.

Thus, from an historical point of view, interconnection practices have evolved with the growth and development of the telecommunications network that relies on universally adopted technical standards for successful performance, as well as the introduction of new technology and the retirement of obsolescent techniques and methods. Interconnection practices are a means of defining these standards and ensuring that they are maintained.

Problems Created by Interconnection Practices

From a cursory observation, one could deduce that interconnection practices are a barrier established by the carriers to defend their vested interests against and technical or economic erosion by the users and manufacturers, who, in turn,

regard the practices as obstacles to the realization of their objectives, the development of their markets and the improvement of their products. Such, however, is not the case.

Most of the problems being experienced today result from rapid growth in the mechanized transfer of information required by the growing proliferation of high-speed data-processing installations. A second contribution to the interconnection problem results from the rapid advance in the technology of information handling, which has motivated the development of increasing varieties of equipment. A third factor in this problem is the development of telecommunications capability in Canada by other than existing carriers; this illuminates an area of competition that was previously unidentified.

Thus, the problem, simply stated, reduces to a description of three points of view. The user is faced with a burgeoning complexity of equipment and services from which he must, at his peril, extract the best combination to achieve the most effective result. When he has made a selection of suitable equipment, he may discover that it connot be connected either to the communication facilities of his choice, or to those he has already established in his organization, without some form of compromise. Moreover, when he has had installed a suitable combination of equipment and communications, he may discover subsequently that he is unable to take advantage of improvements to the terminals or communications, which were unforeseen in the application of interconnection practices.

The manufacturer, from his point of view, undertakes the responsibility for developing new techniques and new hardware or modifying and adapting existing equipment to satisfy the expressed demands of users. He is frustrated if the benefits of such developments are economically neutralized or reduced by the costs of interconnection of communication facilities.

The carriers see the telecommunications network as a vast dynamic organism with inherent economic and technical inertia which must be considered when any changes are planned. For instance, the planning of switching systems for a large municipality involves continuous change to accomodate growth in population and calling habits. Additional capacity to handle growth alone must be planned many years ahead, and requires a minimum of two years, for installation before it is required for use. If the proposed changes are particularly complex, such as the general implementation of Touch-Tone calling, or the conversion from manual switching to dial switching, the time frame can be at least 10-20 years. However, it is quite possible for a user to change his method of transmitting information in a much shorter time and, by doing so, to add a critical load to the local communication system and interfere with other users.

Inevitably, the solution to a problem for any one of these three groups must involve the other two. If these problems are to be resolved through further evolution of interconnection practices, then the resulting practices should appropriately represent the diversity of objectives and needs of all three parties. However, the need to meet individual requirements of users has not in the past been a factor in the evolution of interconnection practices.

Existing Interconnection Practices and Common Carrier Needs

Carrier guidelines relating to the connection of their facilities with terminal devices owned by others differentiate between terminals to be connected to their family of private-line services and terminals to be connected to the general switched network.

For private-line systems, the carriers, including CN/CP, have established technical criteria as the basis of definition of terminal connection requirements. Generally, these standards are the only ones imposed on customers requesting interconnection, though protective interfaces may be required, as determined by these technical standards. This statement does not necessarily apply, however, when and if the private-line service has access to public telephone services. No serious problems were identified that resulted from users being required to meet the carriers' established requirements for the interconnection of customer-owner or leased terminals with carrier-supplied private-line facilities.

The most difficult area in which to establish precise guidelines from the carriers' point of view, is that involving the interconnection of customer-provided terminals with the general telephone network. There are a number of reasons for this, all of which do not act in concert in the solution of any particular problem.

First, all the Canadian carriers undertake the responsibility of providing and maintaining a satisfactory level of service to all their users. They have advanced control of the network, including its terminals, if they are to maintian a desired quality of service to all users. Through this control, the carriers must be able to guard against technical pollution of their network from other signal sources; to prevent the use of systems or procedures by one user that could interfere with others and degrade the service; to ensure the safety of employees; and to design their networks consistently with the provision of effective maintenance. These arguments are included in appendices 1,2 and 3 of this study. For instance, one problem complicated by the use of terminals and facilities of mixed ownership, with terminals and facilities of mixed ownership, which tends to be ignored, is the requirement for more extensive administrative procedures to identify and correct sources of trouble. Due to the probabilistic nature of the traffic on the switched network, a terminal connected without suitable

safeguards could continually interfere with other users on a random basis and go undetected for a considerable period of time. Another area of concern arises from the manner in which a terminal addresses the network to activate the switching process. Terminal outputs which deviate from network requirements cannot only degrade the service to the owner of the terminal, but can also interfere with the service to other users.

Though these technical arguments leave little room for doubt as to the need for the carrier to be in complete control of the technical performance of the total network, it does not necessarily follow that the only effective means of maintaining control is through ownership. Yet, from a review of the interconnection practices of the Canadian carriers, it is observed that the responsibility for providing and maintaining the service is conditional on their ownership of all terminals directly connected to the network and the interface through which any others may be connected. Though based on technical reasons, this requirement for ownership immediately raises economic issues which affect both the user and the manufacturer of terminals.

For instance, each telephone company in the Trans-Canada Telephone System provides telephone sets that it has selected as a standard for use in its own operating area. Thus, the market for telephone sets is preserved for the supplier of that particular telephone company. Any other telephone sets, regardless of manufacture, that a subscriber may wish to use must be inspected by the telephone company's representative, for a fee, and, where necessary, parts or components must be replaced at the users' expense to meet the network standards. Another example involves the provision of communication terminals not manufactured by the carrier. When sufficient need arises, the telephone company may supply, as part of its service, terminals purchased from a particular manufacturer. This terminal device is usually manufactured to specifications of the carrier and any interface will be included in the price of the service, rather than as a separate charge. However, should this set be purchased directly from that manufacturer, the user would be required to interconnect it to the telephone network through a separate interface supplied by the carrier, at an appropriate rate. Thus, terminals such as radio set for mobile communications, switchboards, multiplexors, etc., must be interfaced with the network according to interconnection practices when purchased by the user, even though they are identical to those provided by the carrier.

The carriers support this approach for maintenance reasons. When they provide the terminal as a part of the service, they are responsible for maintaining its operating characteristics to meet the network standards continually. This includes making any necessary modifications and chages that are introduced by the supplier from time to time to extend the life of the terminal, to reduce the number of repair visits per year, or to improve parts that time-testing may show to have been originally inferior. Experience has persuaded the carriers that

the user cannot be relied upon to make such modifications, or even to maintain the equipment in its original state, particularly if there is no apparent improvement that justifies the cost.

Another economic issue arising from the technically based interconnection practices involves the derivation of carrier rate-structures. For instance, the uniform charge or "flat-rate" applied to local telephone service is derived from a number of cost factors associated with the provision and maintenance of the local service. Included in these factors is the cost of the local switching equipment. Even though subscribers can make unlimited use of the local switching equipment, their calling habits are predictable, and the resulting traffic forecasts are reliable when applied to voice traffic. However, when non-voice communication terminals are connected to the network, the resulting traffic load is unpredictable beyond the fact that it can exceed the average calling rate by factors as high as ten. At the present time rates have not been derived by carriers to cover the increased costs generated by these terminals, and though it may appear obvious that some form of message rate will be required, the additional cost of installing such equipment in the local switching complex is substantial in itself, and would certainly work against the use of such terminals to satisfy individual needs of subscribers. A similar problem appears when these terminals are used on the long-distance telephone services.

Thus, if the individual user needs are to be satisfied, some consideration must be given to new methods of deriving rates that would permit the carrier to recover the associated cost increases without denying the user the economic advantages of using terminals of his choice, or restricting the manufacturer in developing new and improved terminal devices. Historically, message rates have been based on time and distance factors, which are inappropriate for new varieties of communication terminals becoming available. It is possible that the carriers will need to consider information flow in terms of quantity and speed as the basis for terminal rates, with little emphasis, if any, on the distance that information travels.

The carriers do not consciously intend to limit the development and use of new terminal equipment, but in the absence of reliable means to anticipate the results of broader interconnection policies, and in the light of events that have occurred in large metropolitan cities such as New York, Chicago, and Los Angeles, there is sincere reluctance to increase the risk of degradation of service to existing and future users of the network by changing these policies until the more cirtical issues associated with them are resolved. Some changes have been made, however, to accept the interconnection of acoustically and inductively coupled terminals, but some of the techniques involved in this interconnection may be made obsolete by proposed changes to the telephone set which are being considered.

Summary of Carrier Needs

The carriers must be accountable and responsible for the design and complete control of the common user network if it is to be improved and expanded to meet future needs. Interconnection practices are a means of ensuring that these objectives are met. However, in the opinion of the carriers, the risks involved in broadening these practices to better serve the individual needs of users and manufacturers appear uneconomic unless they can be shared through the judicial establishment and maintenance of standards and objectives accepted by all parties involved. Such standards would reflect technical and economic objectives and deal with such subjects as competition, developement of technology, grade of service, and revenue to carriers. Since these issues are the subject of other "Telecommission" studies, further discussion is not attempted here. It is recognized, however, that additional studies to consider the impact of these issues on interconnection will be required before any significant change to interconnection practices can be undertaken.

Future Interconnection Practices

A number of factors could affect or change the interconnection practices presently established by Canadian carriers. Policy decisions, for instance, in fields such as regulation, the degree that competition is permitted in the marketing of telecommunication services, the requirement to develop a strong Canadian communication equipment-supply industry, even changes in the corporate organization of communication carriers (particularly as it affects ownership and/or market to be served), the development of Telesat service and the manner in which it could provide communication services - all of these would be expected to have an impact on the evolution of interconnection practices. Since many of these topics are under study in the Telecommission and are being participated in by representatives of the carriers, any projection of future trends affecting terminals is limited to the existing guidelines. Thus, the carriers plan to continue to control the maintenance, administration, and long-term system design of their networks, and expect that, through the development of suitable interfaces and improved service offerings, a reasonable balance will be provided between the market needs and the protection of the common user network.

CHAPTER 3

User Requirements for Interconnection

Users have growing requirements to serve their individual needs through the general telephone network by the interconnection of terminals leased or purchased directly from equipement suppliers rather than from the carriers. Separate consideration is given, first, to general industrial requirements, sourcing from product manufacturing and marketing oriented industries; secondly, there are special applications for information systems used by organizations such as policeforces, utilities - gas and electrical, etc. and the broadcasting industry.

Industrial User' Needs

The users' problems of interconnection stem primarily from increased pressure to move more information faster and cheaper without loss in quality. Rising administrative costs can often be attractively offset by the mechanization of information systems when it results in the transfer and use of information by more people in a shorter time. Effective inventory control, sales order completion and delivery, production processes, market research and analysis, etc., are only a few of the many industrial applications presently utilizing communication terminal devices, and, because of the variety and scope of these system objectives, there are requirements for terminal devices of parallel dimensions.

These information systems can be broadly classed as follows:-

1) Data Collection or Distribution Applications -

   Data are collected and transferred to a central processing point and distributed from there according to need. The increase in the number of these systems results from the efforts of system designers who are striving to reduce the number of times data must be manually converted, thus reducing clerical costs and error rate.

2) Enquiry Processing Applications -

   Central data files are established which, when accessed at random from local or remote terminal locations, can

provide fast responses to the enquiries. These systems are particularly effective in marketing applications, and are being developed and used by large catalogue suppliers, among others.

3) Network Control Applications -

When a central processor is required to handle a large number of information systems, it may require fast access to a broad spectrum of communication services to accomplish its objectives. Because of the size of these computer installations, there is a trend towards the development of special purpose communication control computers to act as the communications manager for the larger processor.

In all these data-transmission applications, the terminals must be selected to utilize the medium involved (magnetic tape, punched cards, paper tape, etc.), to operate at the appropriate transmission speed, and sometimes to perform multiple functions as determined by their programming capability. To be effective, however, these terminals must have a connection to compatible communication services, which the user would like to utilize as efficiently as possible. Thus, if he has a large data file which is to be accessed by a number of remote low-speed terminals grouped in large centres, the use of multiplexors to derive channels from available telecommunication services can result in increased efficiency and economy in the utilization of his communications. However, interconnection practices presently permit only limited use of customer-owned or leased multiplexor equipment.

User Problems

Terminal technology has proceeded as rapidly as computer technology, but because of the seemingly infinite variety and combinations of functions that can be included in a terminal, together with the ranges of quality, the user cannot reliably or easily select the best available combination of terminals and communications for his particular needs. Assistance may be obtained from manufacturers who provide some advisory and consulting service, from independent cataloguing organizations such as Auerbach, or from systems consulting firms etc., who attempt to catalogue and publish lists of equipment with associated manufacturers' specifications. However, there is no central coordination of such assistance or even agreement among those supplying it when specific recommendations are required, and the user, without the necessary skills to evaluate equipment on his own, has no reliable standards for reference.

Even with the best of skills available, many limitations may not be discovered until after the terminals have been in operation. Problems affecting the grade of service can result from an unexpected demand for a variety of terminals, which

neither the carrier, the manufacturer, nor the user could anticipate or control without interconnection practices to buffer the impact. For instance, the use of automatic reporting devices (alarms), to advise utilities or police departments of circumstances requiring investigation, can seriously degrade both the local communication system and the investigative operations unless appropriate controls are applied to the connection and maintenance of such devices and the objectives they are to serve. Similarly, when a manufacturer introduces a new terminal, his research may have uncovered only a few of its potential uses. The effect of its use under these circumstances may favour its interconnection to the general telephone network. Later, when users find additional needs that the terminal can serve and that can be handled by the local switching network, it is then very difficult for the carrier, the user, or the manufacturer to coordinate the growth in use effectively.

Users have felt that there is a serious need to establish accurate classification standards for telecommunication terminals with respect to performance, interfacing requirements, information transfer capability, etc. in such a way that terminals meeting these standards could be connected to the carrier facilities at the users' discretion.

This need could be served by an agency, supported by government authority, and established to develop standards, coordinate their use and also act as a certification authority. This agency would need to review continually both existing and new terminals and, of course, would have to deal with the problems of decertification when appropriate.

One developing variety of terminal device that should not be overlooked is the multiplexor. Their main function is to derive chanels from a selected bandwidth as required. For instance, a multiplexor may derive twelve 300 baud channels from one voice circuit after the network connection is established. Though these terminals are more appropriate to private-line use, some system designs have applied them to private lines between large centres but which are connected to the local switching in one or both locations. Interconnection practices at present, limit the manner in which multiplexors may be used, and appear to deprive the use of benefits he could obtain from more efficient use of his communication channels.

The use of multiplexors has both economic and technical advantages to the user. From the technical point of view, flexibility in the use of bandwidth at the users' discretion is particularly attractive. Among the economic advantages is one that results directly from the telephone carriers' rating structure for voice channels; for example, the user may obtain twelve low-speed channels more cheaply by deriving them from a voice-private-line than he can by leasing twelve separate low-speed channels directly from the carrier.

The employement of user-owned or leased multiplexors would appear to the users to have significant long-range advantages which will not be fully realized without appropriate changes in interconnection practices and rating structures.

Summary of General Industrial Users' Needs

The general industrial user primarily requires the flexibility to select the best combination of communication terminals and facilities to serve his individual needs. To assist him in the selection of suitable terminals and to anticipate their performance, reliable standards and procedures must be established so that accurate comparisons can be made during the selection process. These standards should be applicable throughout the life of the terminal to ensure that it continues to satisfy the system objectives and the technical specifications established for its interconnection with the network.

In order to deal with obsolescence of the terminal, or the communications, or the system, there is a requirement for authoritative procedures that will coordinate changes with the parties involved. Any broadening of interconnection practices must define the extent of the users' responsibility for maintaining his terminals to meet network standards, including modifications that may be required from time to time. These procedures would recognize the flexibility required, the freedom of choice of the user, and the objectives of the manufacturer to improve his product continually.

Any one of a number of administrative techniques could be employed for these purposes, and their consideration should ve the subject of a continuing study that would include users, carriers, and manufacturers.

Special User Applications

The terminal requirements for police organizations, gas and electrical utilities, and the broadcasting industry are peculiar to these different organizations. For example, the control and operation of pipeline transmission systems require special remote monitoring, metering, and control of terminals that must operate under standards of reliability different from those used by electrical utilities. Similarly, all these organizations, inlcluding police departments, use mobile radio terminals for despatching personnel and obtaining reports from remote locations. However, the reliability required by these different users has not yet been defined in terms of standards accepted by the users themselves.

Electric utilities and pipeline companies can each establish their own standards of reliabiliby and maintenance of service for their own operations with the resources available. Thus, for a private mobile radio system provided by the user to handle his despatching function, it is often desirable to re-

arrange one or two terminals in the system for interconnection with the public network in such a way that the other terminals on the system can call those stations and be transferred. With the exception of police forces and emergency services, interconnection practices at the present time do not usually permit such interconnection unless the total mobile system has been provided by the carrier.

Until standards of reliability and security, where required, are more precisely defined and universally adopted, the carriers are reluctant to relax interconnection practices in these cases. From their point of view, each situation is different, and there is very little opportunity to provide higher standards on a broader base compatibly with economies of scale. As a result, the user continues to insist on ownership and control of communication terminals and facilities required to serve his needs.

The broadcaster has a unique interconnection problem in that he must produce a "beep" tone whenever his broadcast facilities are connected directly to the switching network. The production of this tone at the interface was a practice that some of the telephone companies originally insisted on to protect the privacy of their users. The cost of this interface is, of course, borne by the broadcaster. The resulting inconvenience to listeners, particularly in long interviews, resulted in additional interfacing equipment being developed that would erase the "beep" tone going out on the air but would retain it on the line to the telephone user. This "debeeper" produced a more satisfactory result at additional expense. Recently, the introduction of acoustic couplers has reduced, if not eliminated, the need for an interface. The carrier still feels obligated to protect his user, but finds increasing difficulty in maintaining this position.

Another broadcasting requirement involving interconnection is in the collection of news. When reporters phone in directly over the switched network to report news items, there is a marked degradation of transmission caused by the standard telephone transmitter. In some frequently used locations, the carriers have installed interfaces which permit special microphones and coupling amplifiers to be interconnected whenever calls for broadcast are made. However, no technical solution has been devised that will allow any pay station or telephone sets to be used in this way.

Summary of Special Users' Needs

Standards of reliability and security required by users who provide essential and emergency services should be developed competently defining the users' objectives and needs. Terminal suppliers and carriers could then compete in this market and develop techniques and equipment to realize any economies of scale. From these standards, technical interconnection practices

could be established to satisfy the objectives of the carrier, the user, and the manufacturer.

In broadcasting, consideration should be given to procedures that will permit the user to maintain a high standard of transmission quality while affording whatever protection telephone users may require from unexpected calls that are going directly out on the air.

CHAPTER 4

Manufacturer Requirements

From the manufacturer's point of view, interconnection practices established by the carriers appear to add more economic hurdle to the successful marketing of their products. The relatively small Canadian market for telecommunication terminals is served not only by Canadian suppliers but also by foreign manufacturers in the United States, Europe, and Japan. These foreign products are particularly attractive to the user, due to the variety of the available product-lines, and, unfortunately, without a larger home market for a base, Canadian products are not similarly attractive to foreign users. Thus, the Canadian manufacturer needs as much assistance as possible. To some degree, interconnection practices can work in this direction. In the application of present interconnection policies, the carriers can and often have shown a preference for Canadian products.

However, as applied to radio terminals, interconnection practices appear to inhibit competition with the terminals the carriers provide with their service. For instance, carriers do not permit the electrical interconnection of customer-owned radio paging devices with their network, even though it could increase the scope and importance of the terminal to the user. When a similar paging service is provided by the carrier, it can be accessed directly from the public network.

A communications expertise has been developing within the manufacturing industry which is capable of competent system design and the recognition and developement of effective standards. This expertise has developed communication systems such as the radio systems used by the restricted common carriers, extensive intercom systems in large buildings, as well as systems employing microwave and switching techniques. If suitable interconnection standards were established and published by the communication carriers, this design expertise would have greater freedom and opportunity to grow, which in turn would require manufacturers to develop terminal devices for direct connection to the network under conditions that satisfy the needs of the user and the carrier. As mentioned in the previous chapter, the relaxation of interconnection practices to serve these objectives would require a definition of the responsibility that must be undertaken by the user and the manufacturer.

Although manufacturers believe that the relaxation of interconnection policies would accelerate and improve the market for their products and encourage the developement and improvement of Canadian products, some questions about the longer-range situation arise.

For instance, it must be assumed that foreign compeitors would soon employ similar standards for terminals sold in Canada, and one must ask whether such a move would result in even more difficult problems for the Canadian industry. It was pointed out that markets for this type of equipment in Europe and Asia are presently unavailable to north American sources.

Thus, a unilateral move in the direction of changing interconnection practices of this nature by Canada should be undertaken only after a thorough study has been made of the probable consequences, both short-term and long-term, to the user, the manufacturer, and the carrier.

CHAPTER 5

Summary and Conclusions

The requirement for interconnection of customer-owned terminals with the carrier-owned public network has been initiated by the user, or by the user together with the manufacturer of terminal equipment. Until the requirements for transmission of machine data emerged in substantial quantity, the pressure from users and manufacturers on the carriers to interconnect terminal devices was not considered significant. During the past few years, a very broad spectrum of telecommunication terminals, particularly oriented to the transmission of machine information, has been developed and produced to serve both the growing quantity and variety of users' needs. The carriers have recognized the changing needs of users, and have developed certain facilities and services to handle these new requirements. The pace and rhythm of this recognition nevertheliss do not seem to have eleminated the problems.

The carriers' interconnection practices became a serious problem for the user when he discovered that he could not combine the optimum choice of communications terminal and carrier facility. Wtihout this opportunity, his system objectives must be compromised. The carrier has always undertaken the responsibility of providing a suitable standard of service and maintenance to all customers, and generally insists that this can be most effectively provided if the terminals are owned by the carrier.

The manufacturer of communication terminals has particular difficulties, for he may have to sell his product to both the carrier and the user, and under different circumstances. If he is able to sell his product consistently to the carrier, interconnection practices can act as a proctection for his product. If the user is his only market, then present interconnection practices appear to be a barrier, particularly if his product is not compatible with existing practices.

Thus, the carrier practices relating to the interconnection of customer-owned terminals have in a sense generated a triangular set of forces between the carrier, the user, and the manufacturer, which cannot stay in equilibrium without continuous attention and negotiations on the part of all three.

The factors whcih probably upset this equilibrium are distributed among the three parties. Pressure comes from the user because of his requirement for flexibility in the selection of terminals and communications. The carrier's pressure can come

from his regulated rate structure which may interfere with the utilization of certain services. The manufacturer introduces the pressures of innovation. Since the manufacturer of terminals has considerably less inertia than that entailed in the maintenance of a vast communications network, more advancing communications technology is being introduced in the manufacture of new and unique terminals than could be possible in the communications network.

These pressures have now reached the point where they can be maintained in equilibrium only by negotiation, since there is essentially nobody with authority to act as a referee. Thus, there is a tendency and an opportunity for the largest users to negotiate preferential interconnection arrangements and, because they are large, they can undertake the necessary responsibility for terminal ownership and maintenance to the satisfaction of the carriers. Similarly, the large user can negotiate successfully with manufacturers to receive the benefits of modifications and improved maintenance procedures. This is not to suggest that problems do not exist for the large user in this triangle, but rather that tolerance for compromise on all sides is predictable, and thus stabilizing.

Problems resulting from interconnection practices are usually most serious to the small user of telecommunications equipment, since he is unable to obtain quantity discounts from the manufacturer or undertake the responsibility of maintaining the technical standards required for network connection by the carriers. However, his requirements for flexibility in the selection of terminal equipment and communication facilities may be even more critical and important than those of the large user.

From this study, there is substantial support for broadening interconnection practices for terminals. Changes must be undertaken, however, with the participation of users, carriers, and manufacturers, and could not be made until a number of issues related to interconnection have first been dealt with. Some of these issues are: -

1) more precise definition of the carriers' responsibilities to the users and the manufacturers with respect to the services they provide, and the associated maintenance standards;

2) the degree of competition that should exist between telecommunications carriers;

3) the responsibility of the manufacturer to the users and the carriers, and to what degree the market for all telecommunication terminals should be competitive;

4) the responsibilities of the user, with particular regard to interconnection;

5) the influence of approved rates, since some interconnection practices are related to regulated rates which are difficult to change.

In addition to the above issues, there are some of a technical nature which must be considered before deciding on any machanism or organization to control or influence interconnection practices.

At this point, it should be noted that the conclusions reached in a study of the technical aspects of interconnection by the national Academy of Sciences in the United States for the F.C.C. were supported by the Project Team; a copy of the report is appended. The principal conclusions are as follows: -

a) uncontrolled interconnection can cause harm to personnel, network performance, and property;

b) the signal criteria (described in the tariffs) relating to signal amplitude, way form, and spectrum are technically based and valid and, if exceeded, can cause harm by interfering with service to other user;

c) present tariff criteria, together with carrier provided connecting arrangements, are an acceptable basis for ensuring protection;

d) present tariff criteria, together with properly authorized and endorsed program of standards development, equipment certification and control installation and control installation and maintenance are an acceptable basis for achieving direct user interconnection;

e) innovation by carriers need not be significantly impeded by a certification program. Opportunities for innovation by users would be increased;

There can be no doubt about the growing importance of serving the users' needs. There is also no doubt that these needs are going to become more and more specialized and will require more specialized responses by the communication and equipment suppliers. If needs demand innovation and change at a faster pace than is economically viable for the carrier and/or the manufacturer, some influence must be applied so that the user may be directed towards objectives that are feasible for the carriers and manufacturers.

Users see a need for a federal agency with the necessary technical and regulatory authority to deal with interconnection issues on a continuing basis. This solution is easier to conceive than to implement due to the larger number of relationships involved, including those of federal/provincial jurisdiction. Although the ultimate mechanism is difficult to

visualize until some key issues have been dealt with, the next step is clear. The user and the manufacturer must be able to participate directly with the carrier in the formulation of any new or changed interconnection practices, and it would appear that this step be effectively taken through legislative action.

TELECOMMISSION

Study 8(c)

Northern Communications

The Department of Communications

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Ottawa, 1971

This Report was prepared for the Department of Communications by a project team made up of representatives from various organizations and does not necessarily represent the views of the Department or of the federal Government, and no commitment for future action should be inferred from the recommendations of the participants.

This Report is to be considered as a background working paper and no effort has been made to edit it for uniformity of terminology with other studies.

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CHAPTER I

Northern Communications - General Appreciation

Canada's North is an enigma. It is both an old and a new land. Over thousands of years people in the North have devised and evolved a civilized culture despite the obstacles of climate and desolation. Yet it is a new land that we in the South are beginning to know and understand. We live in a decade when the dream of developing the North must be realized to foster the emergence of Canadian identity and horizons.

Communications are vital to initiate and sustain northern development. Communications can be a catalyst for cohesion and growth, and can overcome the barriers of distance and isolation. Telecommunications, meaning telephones, data, radio, and television, are one facet of communications which, in the broadest interpretation means an exchange of facts, ideas, opinions, and emotions between people.

The need for improvements in northern communications becomes more apparent every day. Requirements will increase as the pace of development accelerates. Existing systems are often inadequate or worked beyond their capacity. Careful planning is essential to ensure that effective communications for the future are available. A scheme of communications priorities must be prepared which is feasible, economical, and responds to anticipated needs; communications must be used first as an instrument of creation, then as a medium of consolidation, and finally as a means of recreation.

A new look at communications in the North is necessary. The task is no less than the completion of the building of Canada. But the difficulties in bringing an acceptable standard of communications services to the North are enormous. The territory is vast, the population is sparse, and the physical handicaps present a challenge that only foresight and imagination can surmount.

There is every indication that Canada's Arctic contains one of the world's important sources of oil and gas. A major find of these fuels anywhere near the scale of Prudhoe Bay would bring massive changes to the Canadian North. The technology for the extraction and transportation of fuels is well advanced and attests to the confidence that major discoveries are highly probable. Increasing energy scarcities in North America and instability in

the Middle East will guarantee that the exploratory activity must intensify.

The voyage of the "Manhattan" in the Northwest Passage resolved one very important issue. The indications now are that fuels will be brought from the High Arctic to southern Canada by pipeline. The Mackenzie route appears logistically favourable. Such a pipeline will need communications. Communications will be required during the construction phase and for control purposes when the pipeline is installed. High quality microwave systems will be needed to carry the control circuits safely and without degradation. It will provide the means to serve all communities within interconnection distance with a full gamut of telecommunications facilities.

The "Manhattan" also opened our eyes to the Eastern Arctic. The ship successfully navigated large sections of the Northwest Passage where minerals occur in abundance and with unusual purity. The tremendous ore bodies on Baffin Island lie temptingly close to the route taken by the "Manhattan".

Promising developments are also on the threshold of advancement in Northern Quebec. Huge nickel and asbestos deposits occur near Deception Bay near the Hudson Strait. There is a possibility of a major hydro-electric development on the west coast of James Bay.

There are areas in the North that are less conducive to economic progress. The District of Keewatin is in the early exploration stage but the type of industrialization that would provide a base for drastic communications improvements is not anticipated for some time. It is representative of areas where there has been concern expressed for improved telecommunications facilities essentially to meet social needs. Such areas present problems of capital investment for the telecommunications common carriers. In achieving the social objective of extending the widest access to telecommunications, the unit cost of terrestrial distribution bears an inverse relationship to population density - a feature that is apparent for both telephone and broadcasting services. It follows that, if equal service is to be provided, the cost per capita will be higher where the population is more widely dispersed and, for that reason, even more dependent on telecommunications than the urban population. This raises the difficult question of the extent to which these additional costs, attributable to the general objectives of social well-being and economic prosperity, should be borne by the direct beneficiaries, by the subscribers to the system, or by the general taxpayer.

It is necessary, in communication terms, to find a new definition for "the north". The geographers' definition of the north is the region above the southern boundary of the Yukon and Northwest Territories, which lies, for the most part, along the 60° parallel of latitude. But studies have revealed that areas of communication inadequacies extend deep into the southern parts of

the Provinces. Generally speaking the lack of telecommunications services occurs at the 55° parallel in the Provinces of British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, and Newfoundland. It is estimated that there are about 32,000 people in the Northwest Territories, 18,000 in the Yukon, and about 196,000 people in the region between the 55° and 60° parallels. Throughout this great area, men have found it necessary to pool their resources if life is to be tolerable; governments have generally been less successful, perhaps because conventions and rules that have been found effective elsewhere may look foolish when they are frozen.

The provision of efficient communications in the North affords no exception to the need for a common approach and a pooling of resources. The situation now is that the dearth of reliable common carrier services has meant that agencies have installed their own systems. Unfortunately, the proliferation of systems not only deteriorates overall service, but reduces the economic base for the expansion of commercial services. Communication surveys have demonstrated that the public, government agencies, and industry are not even receiving a minimum standard of service in northern areas. About 240 communities or settlements have been identified as candidates for new or improved services. Some of these have populations up to 500 and a few of 800. In establishing these requirements the premise was assumed that every permanent settlement having a population of over fifty persons should have facilities for telephone service not subject to outages due to atmospheric conditions.

Care must be exercised in not considering the North as a homogeneous area in meeting communications needs. The areas of prime concern are (1) the Districts of Franklin and Keewatin (2) northern Saskatchewan and Manitoba (3) northern Ontario and Quebec (4) northern Alberta (5) northern British Columbia and Newfoundland.

At the Northern Communications Conference, which was held at Yellowknife in September, 1970, it became evident that the principal concern of people who live in the North is that their special requirements for communications demand priorities different from those established by outsiders without regard to local conditions. The appeal of radio broadcasts is lessened if the language is not understood; live television is all very well, but not particularly relevant for someone who is sick, or lost, and in need of assistance. The outstanding demands, it appears, are for reliable two-way fulltime voice-communication services, and for a broadcasting system which would permit local programming, opportunity for participation in community affairs, and better education.

An examination* was made of the technical options available to serve the North with improved communications. Three different techniques emerge. First there is the communication satellite and its promise to bridge electronically the distance and the silence. Then there is High Frequency (HF) radio and the more scientific application of this medium for upgrading commercial service. Finally there is the extension of terrestrial facilities using radio relay, troposcatter, cable, and wireline systems. Included in this category is the suggestion that attention be given to using the DEW Line and Polevault Systems more extensively for civilian communication purposes.

The Canadian North is ideally suited for exploitation of communication satellite technology. Communication satellites can provide direct high quality communication channels to locations without regard to distance or nature of terrain. Much of the Eastern and Central Arctic is such that it does not appear to be ever economically possible to provide an acceptable service to most of the settlements using conventional means. Studies of satellite potential have been done using the ANIK satellite, since this would provide solutions at the earliest time. Concurrently an investigation was made of the possibility of developing a communication satellite system specially designed for northern service.

The use of a communications satellite to provide service to individual subscribers in isolated areas carries with it a number of problems which will require considerable effort before satisfactory solutions can be worked out. New and sometimes unique solutions will have to be obtained to the problems of operating, signalling, billing, numbering, switching, supervision, local distribution, interfacing between the common carriers and Telesat, if the potentials of the medium are to be exploited.

A criteria used in the study of providing service by ANIK was that each settlement should have the capability of transmitting and receiving a single telephone circuit, and be able to receive a single radio program circuit for broadcasting purposes. The conclusion reached was that the cost of renting a channel would be about $3 million annually, and the cost of serving each settlement would be $100,000 annually.

The study of Ultra High Frequency (UHF) satellite revealed that the estimated annual cost per community to provide a single telephone channel is estimated to be about $25,000 for serving about 100 ground stations. This type of satellite could serve as many as 500 communities if a sharing of channels between communities was acceptable. The ground stations would be

* Telecommission Study 8(c) - Vols. 5 and 6.

cheap and suitable for fixed, transportable, and mobile applications. Unlike the ANIK systems, the cost of the service provided by the UHF satellite system would not be offset by revenues obtained from distributing general communications and television in southern Canada. Unlike the ANIK satellite to be launched in late 1972, a UHF satellite must be designed and developed. International frequency allocations need to be set aside for its occupancy of the radio spectrum. Such a system would be possible around 1978.

Much attention was given to the improvement of northern communications using High Frequency techniques. Until the advent of the communications satellite HF radio afforded the only means of communicating over vast distances when small circuit requirements had to be met. The high cost of satellite communications will certainly ensure that HF systems will continue in operation at least in this decade.

There are many ways to improve existing HF radio services. New generations of solid state equipment will enable reliabilities to be achieved which are at least one order of magnitude better than equipment now in service. Reduced maintenance and power requirements made possible by solid state design generally assists operation in northern conditions. Improvements in frequency stability are possible and necessary if coding techniques are to be employed on commercial systems.

But it is in the area of HF propagation and prediction that the most significant improvements in service can be realized. Accurate predictions have been developed and are available within the Department of Communications. The Telecommission served a useful purpose in bringing together scientists concerned with prediction of optimum frequencies for HF services, and the common carriers who are now exploiting the potentialities of computer predictions for improving commercial services.

It is quite remarkable that Canada has been in the fore-front of scientific research and experimentation in HF radio, yet the quality of commercial HF services lags far behind similar services provided by other nations. The closing of the gap behind sophisticated research and marginal operations will demand initiatives by the Department of Communications. New licensing procedures will be necessary to realize the full advantage of HF radio. This may involve (a) closer monitoring of frequency usage (b) publication of guidelines and procedures for the HF bands, similar to those for the microwave bands (c) making available optimum frequency working maps (e) re-evaluation of frequencies assigned large users on a traditional basis.

Two types of terrestrial systems were also considered in the northern content: troposcatter systems and microwave systems.

Troposcatter radio systems provide reasonably good quality circuits with cross-sections to 120 voice channels or more. These systems provide excellent telephone and data services, but installation costs are very high and they are not capable of carrying television. Normally they are heavily supported by large government (defence) contracts.

Two major systems operated by the U.S.Air Force operate in the Canadian North. There is the DEW Line which runs laterally along the Arctic Coast, and the Polevault (North) system for rearward communications to southern Canada. This latter system commences at Cape Dyer and proceeds down the East Coast of Baffin Island and Labrador to Goose Bay.

A finding of the Telecommission Study is that the DEW Line and Polevault systems can be used for the benefit of communities that are adjacent or close to stations of these systems. Communities could be tied into these excellent trunk facilities if simple and inexpensive VHF links were installed. The main stumbling block is the cost of renting circuits for long distances in the DEW Line and Polevault systems. It is estimated that the annual cost of providing the interconnection equipment and rentals is between $50,000 and $100,000.

But it is the long term future of these military systems that must be studied more carefully. There is a possibility that the DEW Line will be phased out in the next seven years. This possibility should be considered and the potential of a re-equipped and re-organized civilian system investigated.

The Polevault (North) troposcatter system is a high quality trunk system that might be better operated by our telecommunications common carriers. Recently the Polevault (South) system was acquired and a similar take-over of the Polevault(North) system should be carefully considered. A decision to take over this system would depend on favourable lease back terms for the rental of USAF military traffic on the system.

Solid state advances in microwave equipment are making radio relay systems less reliant on transportation. Previously, roads or railways were needed before the installation of microwave systems could be contemplated. Now it is possible to enclose low cost equipment in a single weather-proof container than can be transported easily to any part of Canada. Strings of these repeaters can be used to join smaller centres to satellite ground stations or to interconnect directly with southern terrestrial systems. These repeaters make use of power sources integrated into the basic housing design. Fabrication is completed at the factory and once installed isolated repeaters need only be visited one or two times a year.

It is clear that technology for meeting the telecommunication needs of the North already exists. The challenge of the next few years will consist of selecting the right technologies to meet social, political, and economic objectives within limited financial resources.

There is no doubt that an adequate telecommunications base in the North to support social progress, industrial development and government administration, will not be achieved unless a major impetus is given to expansion programs, on a broader scale than has previously been attempted. First, attention must be given to planning and financing to stimulate coordinated activity by the agencies concerned.

Some way must be found to pool plans and coordinate effort. Research indicates that there has been little or no interfacing between groups in many areas and if such a lack of coordination continues there is a danger of incompatible programs blocking national progress.

It seems that there is a legitimate role for the federal government as the coordinator provided that there is no invasion of consitutional functions nor threat of federal monopoly in any suggestions for coordination that may be put forward. Two proposals for a coordinating agency have been put forward* to give concentrated attention to northern communications expansion programs. Participation in the coordinating agency will come from (1) the federal, provincial and territorial governments, (2) the telecommunication common carriers, (3) native associations and representatives of the consumer viewpoint. The main purpose of the agency will be to describe a cooperative approach towards the resolution of northern communications problems.

It is interesting that both suggestions for the establishment of a unique agency to represent all northern interests would possess more than a coordination mandate. The proposals envisage organizations that would not merely be advisory, but have authority to determine procedures and methods, and even to commit resources. Such an organization might eventually evolve towards a development agency. There is no precedent in Canadian history for the type of oganization proposed but that should not be a deterrent to its creation. The organization should be able to absorb regional diversity, particularly since implementation of programs would be computerized according to provincial boundaries and agencies.

An added feature of a coordinating agency is that research activity could be steered and given a sense of purpose and direction. The universities would be brought into the areas of northern research. It might be possible to weld various research and

* Telecommission Study 8(c) - Vol.7 - Chapters I and III

academic units into an effective coordinated program working on a financial basis which would be susceptible to change. A cohesive program would do away with narrowly orientated, poorly integrated task forces.

Other approaches were considered in the Telecommission Study*to effect the necessary coordination, consultation, and participation in the northern scene. A consultative process is typified by the federal, provincial committee on finance; the Canada Water Act offers an example of planning working with a joint federal group; the funding of the Trans Canada Highways jointly by the federal and territorial governments has a record of success that might well be carried over to the communications sphere.

No major expansion of northern communications can proceed without the funding of initiatives on a large scale. Several questions require a response: How much capital should be set aside for the expansion of northern communications relative to other infrastructure, e.g. transportation, housing, education, etc? What amount is required to bring the level of existing services up to satisfactory levels? What should be the proportion of federal, provincial, common carrier and private industry contributions?

An appreciation of the amount of capital that should be invested in communications is a matter of judgement related to tangible returns and the attainment of strategic objectives. It is interesting to note the magnitude of expenditures and revenues in a related field to communications - transportation - as funded by the federal government. The annual federal expenditures for air, marine, roads, and meteorological services in the territories and extreme northern parts of the prairies were $31 million in 1965-66. This increased steadily to $56.7 million in 1969-70. Corresponding revenues were $6.02 million and $10.8 million. The trend is for transportation revenues to increase and the gap between expenditures and revenues to widen.

For comparison purposes a tentative plan submitted by the Trans Canada Telephone System for utilizing the ANIK satellite and providing ground distribution systems puts annual costs at about $10.5 million. Such a plan would effectively resolve most telecommunications problems in the Districts of Franklin and Keewatin, and the Provinces of Quebec and Newfoundland. About $6 million of this amount is for the annual rental of satellite transponders for Telesat Canada. This order of expenditures is not out of line if communications are to be brought to the level of transportation services.

* Telecommission Study 8(c) - Vol.7 - Chapter I

What are the sources of capital that could contribute to significant programs for the expansion of northern communications? First, the telecommunications common carriers might bear losses through cross subsidization as the price for their franchise and the extension of the capability of their networks. Second, the Federal Government might contribute a share to compensate for the difference between annual operating expenses and revenues where facilities are provided at a loss to meet social and non-commercial objectives. Third, user charges above standard rates might in some way be borne by agencies who obtained special advantage from the stimulated expansion of northern services, e.g. Canadian Broadcasting Company and the Ministry of Transport. Fourth, the provinces might contribute to improved communications in the northern extremities of their regions if they require accelerated programs to serve their communication needs. Fifth, private industrial communication requirements might be met by these concerns and not require subsidies unless the overall economic development of a region is envisaged.

The advantages of distributing funding responsibility cannot be over-stressed because major programs can be tackled with less risk and trepidation if the costs are shared.

Northern public telecommunications services are presently provided by two common carriers. North of 60° latitude C.N. Telecommunications serve the Yukon and that part of the Northwest Territories west of 102° longitude. Bell Canada provides public telecommunications services to the east of the 102° longitude in the Districts of Franklin and Keewatin.

This division was apparently made to avoid destructive competition in areas where revenues were low. But it is an unusual division for the circumstances. On the one hand a Crown Corporation operates in an area which is rapidly becoming economically self-supporting while a private corporation serves an area where such a situation will not occur for a long time. Is this arrangement impeding the realization of improved telecommunication services throughout the Territories? The Telecommission Study did not address the optimum common carrier arrangements for northern telecommunications but the question does require examination.

The Telecommission Study has provided detailed information on the magnitude of the problem of expanding northern telecommunications in economic, social, and technological terms. The areas of further work and decision have been identified. It will be necessary to:

(a) verify and authenticate the information collected on communication requirements by survey trips and traffic analysis for each region of the North. This work must take into account probable demographic, social, and economic trends.

(b) Compare, select, and integrate the various technologies into the national telecommunications system and develop a timetable for implementation of planned initiatives.

(c) Investigate the feasibility of a national coordinating body to synthesize the position and views of all agencies active in the North, and to encourage participation by the northern people in the preliminary planning process.

(d) Plan major programs for the expansion of general communication systems for the next five and ten year periods. Particular attention should be given to identifying the necessary research and development to meet anticipated operational requirements in the 1970-80 period.

(e) Determine the magnitude and the sources of funding that are needed to embark on a program of substantial and progressive improvements in northern communications.

(f) Study the adequacy of present institutions for serving the North and consider alternative arrangements to achieve most expeditiously the necessary advance in telecommunications services.

Isolation - spiritual and physical - has been a facet of northern life. Improved communications may be a sovereign remedy. The task is to see that isolation is ended and replaced by sound and effective communications to, from, and within the North.

CHAPTER II

Prospects for Northern Development

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Prospects for Northern Development

Central to the development of the North is the pace of industrialization. In the short run the emphasis will be on the extraction and transportation of fuels and minerals and the construction of hydro projects for energy sources.

These industries are necessary but not sufficient to provide the basis for permanent settlement and sustained growth. Attention must also be given to social development and to the protection of the ecological environment. This chapter is concerned primarily with economic development with particular emphasis on mineral and fuel prospects in the Territories.

The Canadian North can be divided into broad regions when relating economic prospects to telecommunications planning. First, there is the Yukon, Northern British Comumbia and Alberta, and the Great Slave and Mackenzie Delta areas of the Northwest Territories. Economic activity is intense in this general region and telecommunications already exist, or can be seen to evolve naturally, to meet industrial requirements.

Then there is a central region comprising the Provinces of Saskatchewan, Manitoba, Ontario, and the District of Keewatin. Here the pace of development is slow and there is no reason to expect that telecommunications facilities will be forthcoming as a response to the compelling forces evident in the Western region.

Finally, there is the Eastern region comprising Quebec, Newfoundland (Labrador), and Baffin Island of the Northwest Territories. This region is at the threshold of economic development. It can be expected that telecommunications will gradually extend to the larger centres as development proceeds but the prospects for adequate services being extended to communities for social purposes is not great. An added difficulty is that most communities in the Eastern region are well above the tree line with intervening geography both barren and forbidding.

Mineral Potential

The Yukon and Northwest Territories comprise approximately 40 per cent of the land area of Canada and contain large extensions of the Precambrian Shield and the Cordillera areas which are favourable for mineral exploration. Current mineral production in the two

Territories, however, is only 3 per cent of that of the whole of Canada. This comparison suggests that the mineral resources of northern Canada are much less developed than those of southern Canada and the low ratio of developed deposits to possible deposits makes northern Canada a promising area for mineral exploration.

In recent years many, as yet undeveloped, mineral deposits have been located. There are several known lead-zinc deposits in the Yukon and Northwest Territories that are in this category. Two lead-zinc deposits in the Anvil area of the Yukon are estimated to contain 15,000,000 tons of 9 per cent combined lead-zinc metal. Another deposit 120 miles northeast of Anvil is reported to be higher grade, but lower tonnage. In the Pine Point area of the Northwest Territories there are two known deposits of lead-zinc of sufficient grade and tonnage to be brought into production.

Significant deposits of lead-zinc have been found in the Arctic Islands, on Little Cornwallis Island and northern Baffin Island. Underground development of the Baffin Island deposit has commenced. The full potential of all these lead-zinc areas has yet to be determined and there is little doubt that lead-zinc deposits offer the best promise for additional production in the near future.

A number of extensive iron deposits have been located in the North. The Mary River deposit on north central Baffin Island and the extensive Snake River deposits of the northern Yukon, have undergone a series of studies to determine the feasibility of bringing them to production. Problems of transportation, beneficiation and a need for long term contracts at stable prices deter development. Additional sources of low grade iron-ore are being explored on Melville Peninsula and central Baffin Island.

The exploration for gold and silver continues throughout the North and, although a number of small underground mines have had intermittent production, it seems that only high grade silver deposits such as those of the Mayo District in the Yukon and the occurrences near Great Bear Lake are rich enough to support an underground operation. The prospects for discovery of additional economic gold deposits appear to be best in the region north of Yellowknife.

Exploration for copper in the Northwest Territories has centred on the Coppermine River, the Bathurst Inlet area, Victoria Island and the east arm of Great Slave Lake. As a result, several deposits grading 2 - 4 per cent copper and estimated to contain from 2 million to 5 million tons have been located.

In the Dawson Range of the Yukon a porphyry type copper-molybdenum deposit is reported to contain a billion tons of low grade mineral.

Several other similar deposits have been or are being developed in the United States and British Columbia and this latest discovery raises hopes of similar development in the Yukon Territory. It is evident that the North American Cordillera is a very favourable area for deposits of this nature.

Nickel has not been mined in the northern territories since 1962 when the mine at Rankin Inlet on the west shore of Hudson Bay closed. However, the Wellgreen nickel-copper property in the Kluane Range of the Yukon is under development. Recent exploration to the northeast of Artillery Lake in the Northwest Territories has, so far, not given indication of any deposits, however, this area and the Great Slave Lake East Arm area, where two small high-grade deposits are known, continue to receive attention. The Selwyn Mountain ragion of southern Yukon is known to contain at least one deposit of tungsten in excess of one million tons and it is likely that several further deposits may be outlined.

A belt highly favourable for asbestos deposits crosses the central Yukon in a northwesterly direction. The Clinton Creek mine near Dawson and the Cassiar mine in British Columbia just south of the Yukon Border are in this belt. Prospects of finding additional deposits in the belt are considered to be excellent.

Uranium exploration activity has been accelerated in areas containing geological features similar to those of the Elliott Lake area of Ontario and the Wollaston Lake area of Saskatchean, and activity remains high in the areas to the east of Great Bear Lake and to the southeast of Great Slave Lake. Discovery of uranium mineralization in the central Keewatin district will undoubtedly further encourage exploration on the 10 million acres of prospecting permit rights that were granted in 1969.

Everyone associated with the mineral industry in the two Northern Territories is confident that the present expansion will continue. It must be realized, nevertheless, that many of the deposits discovered in northern Canada are still dormant while equivalent deposits in southern Canada are the sites of producing mines. The costs of exploration, development and transportation still remain a significant barrier to mineral exploration and development.

The pattern of mining development that began in 1964 and now dominates the industry in the North demonstrates that the cost factor can be overcome. In that year, Cominco Limited began shipments of lead-zinc ore from its open-pit mines at Pine Point, Great Slave Lake. To encourage this development, the Federal Government co-operated in providing transportation facilities, a townsite and hydro-electric power from a site southeast of Pine Point on the Talston River. Similar co-operation has been extended in later developments.

Not all deposits can be mined by open-pit methods and underground mining will continue in importance. It is, nonetheless-encouraging that many of the deposits being discovered can be developed as large open-pit mines operating on a low cost per ton basis. Developments in the transportation field, particularly the possible lengthening of the shipping season in Arctc waters, will assist both the exploration and development arms of the industry, and while the Yukon Territory and the western provinces of Canada supply markets on the Pacific rim, the future markets for the mineral resources of the eastern and high Arctic regions may be the many-fold industries of Europe.

It may be expected that active mining areas will exist in the North within the next one or two decades in the central and southern Yukon, the Great Bear and Great Slave Lake regions, the central and southern Keewatin, the Arctic Islands and the Arctic region of northern Baffin Island, and that mines will be established many hundreds of miles closer to the North Pole than has previously been the case. The cold, lonely path of the prospector and the geologist will become the daily route of the engineer, the miner, the truck driver and all their associates in the operating phase of the industry.

Oil and Gas Potential

There is every indication that Canada's Arctic contains one of the world's important sources of oil and gas. A major find of these fuels anywhere near the scale of Prudhoe Bay discoveries would bring massive changes to the Canadian North. The technology for the extraction and transport of the fuels is well advanced and attests to the confidence that major finds are highly probable. The increasing energy scarcity in North America and instability in the Middle East will guarantee that exploratory activity will intensify in the next few years.

If oil and gas are found they will probably be transported through the Western Arctic to southern markets by pipeline. Plans are being considered for two piplines for moving oil and gas

from the North. The oil and gas pipelines would have their source in the Mackenzie Delta near Inuvik and Tuktoyaktuk. They would run along the Mackenzie River and cross Northern Alberta to Cold Lake. From Cold Lake they would follow a great circle shortest-distance route to Emerson on the Manitoba-North Dakota border. The pipelines would diverge in the Fort Simpson-Fort Liard area so the oil pipeline could terminate at Edmonton. From Edmonton the oil would be sent along existing pipelines towards eastern Canada and cross over to the United States.

Trans-Canada Pipelines have expressed interest in building the gas pipeline while the Mackenzie Valley Pipeline System is pursuing the oil pipeline possibility. A competitor of Trans-Canada Pipelines, Consolidated International, has also expressed interest in constructing pipelines throughout the Mackenzie River area.

The pipelines would have a diameter of 48" and would lie two or three feet underground in most areas. In some areas they might be supported above ground to avoid permafrost difficulties. The estimated cost for each pipeline is in the order of $1.6 billion. If sufficient reserves of gas were found in the Mackenzie Delta it would be possible to commence construction in 1973. The pipelines could be completed by 1975 and the total complement of pumping stations installed by 1978. These pumping stations would be spaced about 35 miles for the gas line and 50 miles apart for the oil line.

Communications facilities would be required during the construction stage and for control purposes when the pipeline is installed. The ultimate requirement is for about 32 data channels at a transmission rate of 600 bits/second, 5 voice circuits, and some mobile channels along the line.

The permanent communication facility would have to be microwave radio or wide-band cable to satisfy stringent transmission requirements for the long distances involved. If microwave radio is used, it would have to be the large-capacity type to ensure that the data signals are not degraded over the length of the system. This would mean that the system would have spare capacity that could be employed to meet other needs. Since the Mackenzie River poleline system operated by Canadian National Telecommunications from Hay River to Inuvik does not have sufficient capacity to meet anticipated traffic growth, the availability of a trunk system financed by the fuel companies would be fortuitous. It would appear feasible to build a microwave system in about two years if the capital commitment were made.

Hydro Potential

The report "Communications in the Canadian North" shows those areas which have been surveyed for hydro electric potential. No further discussion is given here.

Broader Aspects of Northern Development

Economic development can result in effects that are neither beneficial nor desirable for the well being of the northern people or the environment. The communications planner of the future must consider ecological effects. He will have to take care that high transmission towers do not take a toll of migrating birds; similarly wire systems should not endanger animals in the vicinity. If old lines are abandoned, they should be cleaned up. The caribou should be allowed free movement because many people depend very substantially on caribou and moose for their food. Any disturbance of animal balances is of profound importance to them and the cost of meeting claims for loss of income or food sources must be written into the contingencies which may arise. It follows of course that the most stringent conditions must be worked out to safeguard against indiscriminate hunting by crews. Once the routes for pipelines and communications are reasonably firm, but before they are indelibly written in, the assistance of the Director of Game for the Yukon and his counterpart for the Northwest Territory should be sought. It must be remembered that in addition to natives pursuing the traditional way of life in the Yukon and Northwest Territories, there are many professional big game guides and fishing lodge operators whose livelihood may be affected by injudicious timing of communication construction. A number of recent reports show oil spill problems in such places as the Mackenzie and at Boundary Lake on the B.C.-Yukon border. The communication operators and their construction contractors should be encouraged to seek the advice of experts to ensure their plans and methods do not disturb the people or the ecology.

In addition to developing a sensitive liaison with the native interests and game authorities, the planner should try to minimize fire risks. The Forestry Branch should be consulted at an early stage in the planning not only to ascertain their communication needs but also to secure suggestions for communication routes through low-risk areas.

"The wind of change" blows strongly throughout the North. The planner will hear and read of pressures for constitutional changes and greater local autonomy. Even if these changes occur and take the form of regionalization of the Yukon and Mackenzie with a more protected form of administration for the eastern Arctic, it does not appear that these changes would introduce communication problems that would call for drastic reshaping of facilities in the western region. In the eastern region, a change in administrative direction might complicate communication patterns.

It is urgent that the humanist and social scientist obtain some measure of control over the electronic environment we are creating and bring some of the developments into focus. Dr. P. McTaggart Cowan has addressed this problem and he spells out some of the important parameters confronting the communications planner who is reminded that today he has not only a technical, but a moral responsibility too.

> "The pressures of northward expansion from the populous areas of the south are inevitable; we must get ready for them. Tourism and recreation will be followed by development of communities - slowly for the first fifty years, thereafter at an increasing speed. We must learn now how to develop these new communities, so that we can be ready to provide the environment for man where communication is the medium and the message.
>
> As we spread northwards, networks of high energy - gas and electricity - will cross with networks of renewable resource transportation - water flowing south to the parched throats of the unfortunate humans of the middle latitudes.
>
> We must learn how to create the proper environment for these new communities now. If we do not, the Middle North over the next hundred years will be populated with people who are running away from the new society because they cannot adjust to it and we will have a mammoth social problem. If we do, the Middle North will attract the imaginative members of the next generation - the young and the young at heart. They will have their opportunity to build from the ground up and to create communities to their pattern, and the area will prosper and lead.
>
> We must fill the North with communications and an abundance of energy. These will be practical by the year 2,000."

CHAPTER III

Northern Telecommunication Requirements

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NORTHERN TELECOMMUNICATION REQUIREMENTS

This Chapter is a preliminary statement of telecommunication requirements for the Canadian North. The area covered includes the Yukon and Northwest Territories, and the northern parts of the Provinces of British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, and Newfoundland. Several field trips were undertaken to investigate, first hand, the adequacy of services in the Yukon, Mackenzie Delta and Great Slave Area, Baffin Island, Northern Quebec and Labrador. Surveys of existing telecommunications facilities were briefly made in the Provinces of British Columbia and Alberta. Information on the Provinces of Manitoba, Saskatchewan and Ontario is based on surveys conducted by the Department of National Health and Welfare.

An attempt was made to obtain information on communication requirements in places that could not be visited by the distribution of a communications survey questionnaire. The questionnaire was circulated to as many agencies as possible that were active in the North by the Department of Communications and the Trans Canada Telephone System. Each provincial telephone company was responsible for submitting responses on their provinces to the Telecommission Study. The questionnaire attempted to elicit present and future communication user requirements. An attempt was also made to assess the adequacy of existing communication systems in the areas visited or surveyed.

GENERAL REQUIREMENTS FOR TELEPHONE, DATA, AND TELETYPE SERVICES

There are three broad user categories for northern communications services;

(a) General Public
(b) Government Agencies
(c) Business and Industry

(a) General Public

There is a tremendous need for telecommunications to

serve the general public in northern Canada. This need exists not only in the two Territories but extends deep into southern Canada. A typical community deprived of adequate communications has a population varying from 50 - 800. In the majority of cases these communities are occupied by Indians or Eskimos. These communities have either no telecommunications or are connected into the national telephone network by High Frequency (HF) radio stations that do not provide a sufficiently high degree of reliability.

This study had adopted the following criteria to permit a quantitive assessment of which communities are entitled to improved telecommunication services:

(1) Every permanent community having a population greater than 50 should have at least one telephone channel for intra and inter-regional communication and access to the national telephone network. Local exchange facilities for intra-community use should be provided.

(2) Service should be available on a 7-day 24-hour basis.

(3) Reliability should be in the order of 95% and prolonged outages should not exceed ½ day in the worst (and exceptional) cases.

(4) Communications should be sufficiently private to allow the transmission of confidential information.

It should be appreciated that the above criteria may not find general acceptance, but they can be used as a first attempt to establish benchmarks for northern requirements.

There are circumstances where the establishment of the above criteria will not be completely satisfactory. It may not be desirable to use population statistics as the only assessment index. The planning of communication facilities such as local exchange switching, distribution, and interconnecting toll facilities may require a more effective measure such as household count rather than population as the important statistic.

(b) Government Agencies

Government agencies in the Territories and the Provinces have a requirement to use telecommunications facilities for administrative purposes. They require a telephone voice channel and a teletype channel for connection to regional centres. The telephone channel should meet the reliability and availability requirements discussed above for General Public Services. The teletype channel should be capable of carrying low speed data at a rate of 60 - 100 words per minute. The major government

users are the Provincial and Territorial Governments and their agencies and federal agencies including the Ministry of Transport, National Health and Welfare, Indian Affairs and Northern Development, Energy, Mines and Resources, R.C.M.Police, and the Department of National Defence.

For communities with a population of 300 or more there is a requirement for Telex or TWX service.

(c) Business and Industry

The industrial requirement for the retail traders and the transportation companies is similar to the above government needs for northern telecommunications. But industry has special additional needs particularly in the mining and oil exploratory fields. For oil, gas, and mineral exploratory work there is a need for transportable stations which can be easily moved at short notice. These stations should be able to transmit voice and data signals to a base or regional centre for onward routing to southern Canada. When large industrial projects are launched, such as large mines or hydro works, there is a requirement to transmit many voice channels and data signals at speeds of 1200 and 2400 bits/second.

A general rule for traffic in northern areas is that 75% of telephone calls are of an intra-regional nature. The essential requirement is for remote communities to contact their regional centre where connections can be made to the national network. From the regional centre the major portion of telephone calls are destined for southern Canada.

The North has many special communication requirements apart from services that are to be connected into the national telephone network. The harshness and desolation of the environment and the life of the residents render further communication needs important. Concern has been expressed that many northern residents involved in hunting and fishing activities do not have any means of communicating with their resident communities. More important, they do not have the means to alert their home communities if an emergency develops.

The priorities for telecommunication services are:

(1) A reliable telephone (voice) service so that emergency or urgent situations can be reported and help obtained.

(2) A reliable telephone (voice) service for intra-regional communications both for the general public and government agencies.

(3) A reliable teletype channel for the transmission of hard copy messages by government agencies.

(4) Reliable inter-regional telephone (voice) and teletype circuits.

(5) Trunk facilities for the transmission of audio (first priority) and video program material for broadcast distribution. (See Chapter III).

(6) Facilities for the transmission of medium or high speed data to and from industrial centres.

(7) Telex or TWX connections to communities with populations in excess of 300 for government administration.

Since intra communications are high on the list of priorities the North has been divided into the following regions for planning purposes:

(a) Baffin Region

(b) District of Keewatin

(c) Arctic Islands

(d) Arctic Quebec

(e) Northern Manitoba

(f) Northern Saskatchewan

(g) Northern Ontario

(h) Yukon

(i) Labrador Coast

(j) Northern Alberta

(k) Northern British Columbia

(l) Mackenzie Delta and Great Slave Area

A synopsis of the requirements of the various regions is given below and details are given in the Telecommission Study 8(c) report - Volume III. Attention is given primarily to general public and government needs since the areas of industrial mining and exploratory activity are reviewed in Volume 2 of Telecommission Study 8(c) entitled "Economic Prospects for the Territories"/

(a) Baffin Region

The survey revealed that 11 locations in this area require reliable voice and data communications. Existing service is by HF radio only. There are HF systems operated by Bell Canada, Ministry of Transport, R.C.M.P., and the Hudson Bay Company. The residents of the communities, the Territorial Government, and the transportation companies have voiced their concern about the inadequacy of the public services in this region. The communities where reliable voice and teletype services should be provided, and the distance to the nearest trunk interconnection point, are:

Location	Population	*Distance
Arctic Bay	250	750
Broughton Island	350	300 (75)
Cape Dorset	588	225
Clyde River	292	450 (325)
Grise Fiord	100	900 (600)
Hall Beach	250	475 (2)
Igloolik	530	525 (35)
Lake Harbour	200	75
Pond Inlet	412	650
Pangnirtung	642	175 (125)
Resolute Bay	254	950 (425)

All communities are tied into Frobisher Bay for administrative purposes. From Frobisher Bay there is a heavy requirement for traffic to southern Canada. Frobisher Bay is the regional centre of the Territorial Government and it is expected that traffic to Yellowknife will increase substantially in the future. An urgent requirement exists for reliable communications between Frobisher Bay and Resolute Bay on Cornwallis Island. Resolute Bay is the centre of activity for such communities as Grise Fiord, Arctic Bay, Pond Inlet and Clyde River.

Apart from the requirement of the Territorial Government for reliable communications for the administration of the region, the Department of National Health and Welfare must have reliable communications to support health services. In the event of illness it is important that doctors at Frobisher Bay can communicate with local nurses or area administrators in the remote settlements to give emergency instruction. It is also important for community administrators to contact Frobisher Bay for aircraft if patients have to be flown out to Frobisher Bay for treatment at this regional centre, or for subsequent transfer to Montreal.

* Distances in brackets show how far the community is from the DEW Line or Polevault System.

Airline companies are dissatisfied with the existing services in the Baffin Region. Requests have recently been received from Atlas Aviation to establish their own HF radio system operating out of Resolute Bay. Airline companies have a particularly serious requirement to know the weather and landing conditions before they travel to or from remote communities.

Nordair has expressed strong dissatisfaction with communications in the Baffin Region. They have indicated a requirement for reliable voice and message communications at the following places:

Povungnituk	Pond Inlet
Lake Harbour	Clyde River
Arctic Bay	Broughton Island
Resolute Bay	Pangnirtung
Grise Fiord	

They desire communications to those points from Frobisher Bay and Montreal. In their opinion the present public service is very inadequate and in cases of emergency they have to use the HF radio systems of the R.C.M.P. and the Oblate Fathers.

The Glaciology Division of the Department of Energy, Mines and Resources has two base HF stations on Baffin Island working several transportable stations. It is expected ultimately that the number of base stations will increase to 10, while the number of remote transportable stations may be increased to 20. Messages are carried between remote stations and from the base stations to Ottawa.

(b) District of Keewatin

The survey revealed that ten locations in this area require reliable voice and data communications. Existing service is by HF radio only. There are HF systems operated by Bell Canada, C.N. Telecommunications, the Hudson Bay Company, R.C.M.P. Missionnaires Oblats de Marie-Immaculee, and the Ministry of Transport. Exchange facilities for local distribution exist in most communities. The Territorial Council, the Territorial Government, and transportation companies have complained about the inadequacy of public service in these regions. The communities where reliable voice and teletype services should be provided, and the distance to the nearest trunk interconnection point, are:

Location	Population	Distance
Baker Lake	596	375
Belcher Islands	210	350
Coral Harbour/Southampton Island	310	450
Chesterfield Inlet	220	325
Eskimo Point	480	150
Gjoa Haven	250	225
Pelley Bay	180	225
Rankin Inlet	430	275
Repulse Bay	146	525
Whale Cove	200	225

There is also a community of interest with settlements in the Baffin Region. Keewatin District is presently administered from Churchill, Manitoba. There is a requirement for solid communications, by other than HF radio means, for communications between Baker Lake and Churchill, and between Baker Lake and Yellowknife. The Department of National Health and Welfare has a requirement for reliable communications to support health services. Communications from Churchill to southern Canada are good but there is no reliable system or circuit linking Churchill with the Keewatin communities.

(c) Arctic Islands

There is a requirement to serve seven communities on the Arctic Islands with improved public communications. There is also a requirement for communications in this area to serve government and industry exploration activity and scientific surveys. The Glaciology Division of the Department of Energy, Mines and Resources have a requirement for communications between stations at Barnes Ice Cap (73°W, 70°N), Generator Lake (71°51'W, 69°38'N), and Decade Glacier (69°48'W, 69°38'N). Communications are required between these stations and from the station at Generator Lake to the Per Ardua Glacier (76°35'W, 81°32'N), and from there to Ottawa. The Department has plans for an additional field area at Southeast Ellesmere Island, so that communications from this area will be needed.

It would appear ultimately that this Department will require extensive telemetry networks throughout the Arctic to relay data to Ottawa or some other large centre. There will also be a requirement for voice communications between field operators for emergency and administrative communications.

The major oil companies have expressed interest in transportable stations in the Arctic Islands to transmit voice and data information to points in southern Canada such as Edmonton or Galgary. Presently communications are required for exploration activity. Precise numbers cannot be given for the number of transportable stations required. The oil companies presently work into a private HF radio system to Edmonton. An entrepreneur at Edmonton has recently established a telephone answering service for HF radio to the High Arctic, which is used by many oil companies. There are complaints now that the service is inadequate and that remote stations have to queue for long periods before their calls can be completed. It is noteworthy that the existing HF system is used for voice communications only but that the availability of a medium speed data link has been requested. Another point for consideration is that planning should take place now to meet requirements in the event that there is a major oil discovery on the Arctic Islands.

In summary for oil exploration activity, flexible communications systems should be designed to meet requirements at short notice in areas of the Arctic where oil exploration is proceeding.

The communities where reliable voice and teletype should be provided, and the distance to the nearest trunk interconnection are:

Location	Population	Distance
Bathurst Inlet	50	180
Holman Island	180	325
Paulatuk	100	250
Perry River	50	125
Sachs Harbour	132	260
Spence Bay	270	280
Thom Bay	50	300

(d) Arctic Quebec

There are 26 locations in Arctic Quebec having a requirement for new or improved telephone and data services.

Communities in Arctic Quebec are connected to the telephone network by HF radio. There are also HF systems operated by the Hudson Bay Company. The communities where reliable voice and teletype services should be provided and the distance to the nearest trunk interconnection point are:

Location	Population	Distance
Eastmain	171	120
Fort Chimo	701	400
Fort George	1300	200
George River	194	375
Grand Lac Victoria*	211	30
Great Whale River	965	300
Koartak	97	200
Ivugivik	117	300
Lac Albanal*	200	
Lac Evans*	50	
Lac Simon*	239	
Leaf Bay	50	350
Manouane*		

Location	Population	Distance
Nemiscou	172	
One Goeland Lake	100	
Obedjiwan	400	100
Paint Hills	535	150
Payne Bay	159	275
Port Harrison	515	500
Povungnituk	639	375
Rapid Lake	139	
Romaine	704	
Rupert House	832	90
Sugluk	337	250
St. Augustine*	900	
Wakeham Bay	194	200

* Clarification of the status of these communities is required.

There is likely to be a communication requirement for Raglan Mines on Deception Bay to support a large asbestos operation in this part of Quebec. The requirement is for voice and data transmission. Communications with Frobisher Bay are requested.

Nordair has complained about the quality of services in Arctic Quebec. They are anxious to have reliable communications to the following points:

Fort George	Asbestos Hill
Great Whale	Raglan Lake
Port Harrison	Douglas Harbour
Povungnituk	Wakeham Bay
Ivugivik	Payne Bay
Deception Bay	Fort Chimo

Fecteau Airlines indicate that they are interested in having good communications to the following points: Gagnonville, Seneterre, Paint Hill, Cape Jones, Povungnituk, Sugluk, Wakeham Bay. Mining companies have a requirement for transportable stations.

Occasionally, there is a demand for communication channels handling data at the rate of 2400 bits/sec. (Teletype information is also required at a speed of 100 words per minute.) Error rates of the order of 1 error in 10^5 bits is desired. The usual need is for transportable stations to operate into major centres, preferably those in southern Canada.

(e) Northern Manitoba

There are 34 locations in northern Manitoba having a requirement for new or improved telephone and data services. Most of the communities concerned are populated by Indian people. The requirement is for reliable public telephone service and a communications system to support health services provided by National Health and Welfare. Steps were taken recently to implement an HF radio system by Manitoba Telephone System in co-operation with the Department of Communications and National Health and Welfare. But this is an HF system which is not considered adequate for permanent service because

a) The reliability cannot approach an acceptable level for emergency communications;

b) There is no provision for public telephone service to serve the communities with reliable trunk connections to the telephone network;

c) this system is dedicated to the use of National Health and Welfare only and public access to the system is not possible.

The places where requirements exist are as follows:

Location	Population	Distance
Berens River	763	90
Bloodvein	308	60
Brochet	637	77
Cross Lake	1840	38
Dauphin River	80	28
Easterville	344	25
Garden Hill	1129	208
God's Lake Narrows	887	258
God's Lake	83	258
God's River	50	258
Granville Lake	80	110
Hole River	300	7
Jackhead	242	60
Little Black River	168	18
Little Grand Rapids	450	110
Matheson Island	160	50
Moose Lake	630	38

Location	Population	Distance
Nelson House	1282	35
Oxford House	800	298
Pauingassi	160	120
Pinedock	109	45
Popular River	385	135
Pukatawagan	836	7
Red Deer Lake	62	6
Red Sucker Lake	218	258
Sault Point	60	30
Shoal River	490	
South Indian Lake	477	150
Split Lake	400	15
St. Theresa Point	880	208
Shamattawa	344	107
Wasagamach	450	208
Waterhen	677	40
York Landing	80	8

* MTS state that they presently provide some form of public telephone service in all communities having more then 50 people. Respondents to the Communications Survey Questionnaire do not agree that the services provided meet their requirements.

It appears that the Province of Manitoba is in need of improved telecommunication facilities that will connect the above communities into the national telephone network. The number of HF stations licensed to private operators is in the order of 1,000 stations. Licensees include such diverse agencies as the Department of Indian Affairs, and Health and Welfare for Manitoba, United Church of Canada, Lamb Airways, Sherritt Gordon Mines, Ltd., Central Geophysics Ltd., etc. It is interesting to note that the Manitoba Government Air Services have a very extensive communication network serving northern Manitoba. They have base stations at The Pas, Thompson and Norway House. The system is used for air-ground communications for the agency's operations in northern Manitoba, for aircraft in constant contact with the ground for patrol purposes, and for protection purposes. This agency expresses satisfaction with the capability of its own system to handle its particular requirements, although there is no indication that the public need has been fulfilled.

(f) Northern Saskatchewan

About 50 communities in northern Saskatchewan require improved communications. The communities are inhabited by Indian bands. Most of these communities are tied into a system operated by the Department of Natural Resources of the Saskatchewan Provincial Government over HF radio. The premise is that the service to these communities is not sufficiently reliable, nor is an adequate level of service maintained. The Department of Natural Resources provides telephone service for the general public in addition to a number of provincial departments such as the Departments of Highways, Forest Products, Saskatchewan Power Corporation, Department of Indian Health Services, etc. The Department of Natural Resources serves the northern subscribers with HF radio base stations at

i) Lac La Ronge
ii) Buffalo Narrows
iii) Brabant Lake
iv) Cree Lake
v) Stoney Rapids
vi) Uranium City
vii) Wallaston
viii) Flin Flon
ix) Meadow Lake
x) Hudson Bay
xi) Prince Albert

The quality of transmission of the network, as admitted by the Department of Natural Resources, is unsatisfactory. There are difficulties in transmission and there are difficulties in providing operating schedules on an 8-hr. 5-day week basis. There is considerable jamming of the network in view of the large number of stations in the system.

Specific agencies in Saskatchewan have indicated requirements for special services to support their operations. These facilities are required to

(a) provide trunk facilities for the Department of Education to transmit radio and perhaps television programs to northern schools;

(b) Saskatchewan Power Corporation require more efficient and reliable communication systems for monitoring and controlling the electrical power network;

(c) The Saskatchewan Hospital Services Plan needs a basic reliable communications system between their various hospitals and clinics in northern Saskatchewan in addition to a means of communication with southern hospitals for information, emergencies, etc.;

(d) Industries such as pulp and sawmill operators require reliable voice and data facilities. It is predicted that the pulp and sawmill complex in the Canoe Lake area will require these facilities.

Note: Future needs identified by the Department of Natural Resources include a new air transportation system for northern settlements requiring communications support. Very long range plans for northern hospitals would include data facilities with long line terminals to a central computer for diagnostic and data purposes. The Department of Highways would like a more reliable private communications system, and the Anglo Rouyn Mine has a potential need for a system to carry voice and data transmission to southern areas.

The communities where new or improved voice and teletype services are required and the distance to the nearest trunk interconnection point are -

Location	Popn.	Distance (mi)	Location	Popn.	Distance (mi)
*Albertville	78	on trunk route	Ile-a-Crosse	941	104
*Aylsham	176	" " "	Island Falls	178	60
Beauval	486	85	La Loche	1090	200
Black Lake	415	100	*Mayfair	114	on trunk route
Buffalo Narrows	611	130	*Meath Park	198	" " "
Canoe Lake	320	80	Molonosa	214	15
Chitik Lake (I.R)	260	2	Montreal Lake	90	
*Chitik Lake	134	on trunk route	Patuanak	118	105
*Choiceland	493	" " "	Pelican Narrows	130	35
*Christopher Lake	163	" " "	Pinehouse Lake	336	58

Location	Popn.	Distance (mi)	Location	Popn.	Distance (mi)
*Clemenceau	60	on trunk route	*Rabbit Lake	225	on trunk route
*Codet	187	" " "	Red Earth	372	50
Cree Lake	57	165	*Reserve	187	on trunk route
*Creighton	1904	on trunk route	Sandy Bay	561	65
Cumberland House	628	55			
Deschambault Lake	253	29	*Shipman	69	" " "
Dillon	90	127	Shoal Lake	182	55
Dore Lake	112	72	*Snowden	65	on trunk route
*Dorintosh	102	on trunk route	Southend	114	116
*Erwood	119	" " "	Stanley Mission	156	37
*Flin Flon	527	" " "	Stoney Rapids	123	116
Fond du Lac	398	55	Sturgeon Lake	615	25
*Frenchman's Butte	111	on trunk route			
*Glen Bush	55	" " "	*White Fox	389	" " "
*Green Lake	744	" " "	Wollaston		
*Gronlid	151	" " "	Lake	57	222

* Clarification of the public services available at these locations is necessary.

(g) Northern Ontario

There is a requirement for telecommunications services for telephony and data transmission in 31 locations in northern Ontario. The essential requirement is to support health services of the Department of Health and Welfare. The communities where new or improved communications are required and the distance to the nearest trunk interconnection point are -

Location	Popn.	Distance	Location	Popn.	Distance
Angling Lake	125	170	New Osnaburgh	600	21
Attawapiskat	441	140	North Spirit Lake	100	112
Bearskin Lake	270	170	Ogoki	195	144
Big Trout Lake	550	160	Pikangikum	661	60
Cat Lake	157	75	Poplar Hill	150	80
Deer Lake	120	115	Round Lake	434	
Fort Albany	220	80	Sandy Lake	850	140
Fort Hope	450	85	Sachigo	140	190
Fort Severn	144	450	Slate Falls	110	68
Grassy Narrows	485	36	Weagamow		
Kasebonica	100	167	(Round Lake)	144	150
Kashechewan	350	84	Webique	105	160
Kingfisher Lake	90	111	White Dog	495	35
Lansdowne House	350	100	Winisk	134	330
Lac La Croix	141	36	Wunnummin Lake	209	120
Lac La Seul	506	23			

The Ontario Provincial Government have indicated their dissatisfaction with existing services. They hope to introduce an airstrip program for northern Ontario, and they are giving equal priority to communications improvements in this program. The Department of Communications is entering into a crash program with Bell Canada and the Department of National Health and Welfare to install an HF system to support health services. This system is a temporary measure and will not meet the standard of reliability ultimately required. It is also a dedicated system that will not serve the needs of the general public for a telephone service into the national telephone network.

(h) Yukon

The existing telecommunication facilities in the Yukon for telephone and data service are satisfactory. The only permanent community that is unserved by reliable telephone service is Old Crow in the northwestern portion of the Territory. The Yukon forestry service operates an HF system that is unreliable and not properly maintained but this is for a special purpose where connection to the national network is not a prime consideration. The Commissioner of the Yukon Territory has indicated that he is very satisfied with the quality of service in his Territory.

(i) Labrador Coast

A special survey trip was made to examine the status of telecommunications facilities in Labrador. It was hoped that the information gained from a detailed investigation of this area could be extrapolated to communication problems in other remote areas. The communities where new or improved communications are required and the distance to the nearest trunk interconnection point are -

Location	Population	Distance
Batteau	75	55
Davis Inlet	175	45
Indian Tickle	70	50
Makkovik	400	52
Nain	650	95
Packs Harbour	125	12
Paradise River	150	
Pitts Harbour	60	
Postville	125	47
Rigolet	150	70
Spotted Islands	150	60

(j) Northern Alberta

In northern Alberta the important problem is to provide telecommunications services to communities inhabited by Indian bands. There is a need for reliable trunk facilities and for

* Alberta Government Telephones state that only 5 communities have need for improved services. Conflicting information has been received on the status of services and must be clarified for future planning effort

exchange facilities. The communities where new or improved telecommunications are required, and the distance to the nearest trunk interconnection point, are -

Location	Popn.	Dist.	Location	Popn.	Dist.
Anzac	225	24	Fort McKay	176	13
Atikmeg	420	20	Fox Lake	475	61
Cadotte Lake	85	39	Gambler	183	
Chipewyan Lake	150	67	Garden River	125	72
Conklin	150	42	Gift Lake	370	26
Driftpile River	502		Indian Cabins	63	1
Little Buffalo Lake	105	42	Janvier	191	45
Loon Lake	150	18	Jean D'or	424	32
Meander River	300	1	Sandy Lake	110	19
O'Chiese	500		Sturgeon Lake	735	
Peerless Lake	85	18	Utikoomak Lake	155	

Many oil companies operate extensively in northern Alberta and make use of their own private HF systems for communication to Edmonton. There is a heavy requirement for transportable stations providing voice and data communications into the telephone network.

(k) Northern British Columbia

A requirement for new or improved telephone and data services exists in 14 communities. The need is for adequate connections to the telephone network for public use and to support health services provided by the Department of National Health and Welfare. The communities where new or improved services should be provided are as follows:

Location	Population	Distance
Blueberry River	70	148
Dease Lake	100	267
Eddontenajon	174	250
Halfway River	100	25
Kincolith	412	50
Kitkatla	470	40
Kitwancool	198	15
Nation Lakes	under 250	130
Omineca	96	170
Stewart Trembleur	439	105
Takla Lake	under 250	170
Takla Landing	under 250	170
Tahltan	144	320
Telegraph Creek	150	250

(1) Mackenzie Delta and Great Slave Area

Communications in this area are generally good. Service is provided along the Mackenzie River by the Mackenzie Poleline system. Improved or new communication facilities are required at six communities:

Location	Population	Distance
Coleville Lake	67	
Fort Liard	160	300
Nahanni Butte	85	300
Lac La Martre	168	140
Snowdrift	209	125
Rocher River	150	100

There are difficulties in establishing adequate telecommunication services in remote communities that go beyond a technical problem of establishing connections. One major problem is the selection of people who are prepared to accept the administrative responsibility of telephone company agents. The telecommunication common carriers point out that they have attempted to install emergency facilities in remote communities but have been unable to find local residents who would be responsible for collecting toll revenue. The common carriers also indicate that a population of 300 may represent a relatively small settlement which would not justify the installation of Telex or TWX services. Particularly in the northern parts of some of the provinces, e.g. Northern Alberta, it would be preferable to establish reliable telecommunications at main government centres if a regular aircraft schedule is maintained with the smaller settlements. This view is not shared by government agencies who feel that the cost of transportation could be reduced if high quality telecommunication services were available.

SPECIAL REQUIREMENTS

The requirements stated in Chapter I have concerned the provisio of point-to-point services for public telephone and data services and for certain government agencies, such as the Territorial Governments and the Department of National Health and Welfare, for the transmission of administrative messages. However, there are agencies which operate in the North to serve particular functions, e.g. the Ministry of Transport, Department of National Defence, R.C.M.P., Hudson Bay Company, and the Canadian Broadcasting Company. Their requirements are discussed below.

Ministry of Transport - Navigational Requirements

Air Traffic Control

Positive control of aircraft (both Military and Civil Aviation) over Canadian territory is carried out where radio aids are installed and reliable two-way voice circuits are available on a 24-hour 7-day week (landline, microwave, tropospheric scatter cable).

Flight information and control clearances are transmitted to the Area Control Centre by either peripheral facilities whereby the controller and the aircraft pilot may talk directly to one another, or the message may be relayed by a third party such as an aeradio station. For example, an aircraft in range of Cambridge Bay Aeradio may pass a flight message to the Radio Operator over the air-ground facility and the operator will immediately pass the message to the controller at the Area Control Centre in Edmonton over an ATC Interphone circuit.

Any improvement to the communication capability in the Central Northern Region would enhance the control of aircraft through that area and make it possible to extend the ATC Interphone system to such points as Baker Lake and Coral Harbour through Churchill and Great Whale on the eastern shore of Hudson Bay possibly through Moosonee.

Extension of reliable commercial telephone capability north of Cambridge Bay to Resolute would enhance the ATC capability of providing Air Traffic Services to the users in the Arctic Control Area.

Marine Aids to Navigation

There are 12 Marine Radio Stations north of the 55th Parallel in support of shipping in northern waters including Hudson Bay. These stations provide a safety service to shipping and ship-shore communications for the handling of operational and paid messages as well as providing weather synopsis and forecasts and dangers to navigation. Many of these stations are physically combined in an Aeradio station and all are connected to the national computerized teletype network.

U p to the time of the first MANHATTAN trip in the summer of 1969, no serious communications problems were encountered. This was, no doubt, because the northern resupply operation was planned in advance each year, and because of its short duration and simplicity involving only C.C.G. ships and a few others chartered by the Canadian Coast Guard. This type of operation rarely demanded more than one or two short operational messages from each ship each day and because of the non-urgent nature of the great majority of such messages, delays in reception were often tolerated or even unnoticed. The present system although not 100% adequate for today's type of operations nevertheless meets the needs in normal circumstances.

However, except as now arranged for the LOUIS S. ST. LAURENT, that is radioteletype in the vessel with use of the private MOT circuits from Resolute and Cambridge Bay, the present system is incapable of handling quickly the volume of traffic anticipated if the Northwest Passage is to be used by commercial ships. It is certainly less capable of handling the type of instant communications that would be required in emergencies such as major oil spills, marine disasters, epidemic diseases in ships, etc. Means of direct voice communications with ships in the Arctic are at present unavailable except through the High Seas Telephone Service with vessels within radio coverage of Halifax or Vancouver. Vessels are of course out of coverage of these two stations most of the time during Arctic operations. Another

consideration of the present system is that facsimile transmissions for ice and weather maps, as they now originate from Halifax and Edmonton with a minor contribution from Frobisher, are not received too well in some areas of the Arctic in which C.C.G. ships operate. To sum up, the present communications system is short of being fully adequate for the operations now conducted in the Arctic. However, owing to the short duration of these operations each year and the type and number of ships taking part, it would perhaps be hard to justify high cost improvements in the system except in parallel with an increase in marine activities and a lengthening of the shipping season in those regions.

As far as future communications requirements are concerned, provided that the present plans for exploitations of Northern resources through the Northwest Passage materialize, it is evident that the delays in communications that are now experienced because of lack of coverage, poor propagation, saturation or simply because of lack of means in some parts will then be non-acceptable to the Canadian Coast Guard and commercial users. It is envisaged that, if the Northwest Passage is ever used on an extended season as some people think is possible, the volume of communications will greatly increase because of the greater number of ships in the Arctic and also at least for some time because of an increase in scientific, ice, weather and other information (data) transmitted from each vessel.

Apart from the operational traffic mentioned above, there would also be an increase in communications on the part of individuals in ships, including some Government Coast Guard ships, which would remain in the Arctic for more extended periods than at present.

The advent of mammoth tankers as well as other large type vessels in the Arctic, would bring an extra and very definite need for a Marine Communications System capable of handling a large volume of communications with the shortest delays possible. In this instance, the necessity is apparent of having a system capable of handling emergency communications of the highest priority such as during a marine disaster or even a light grounding involving tankers which could pollute the northern seas and coasts if their oil cargoes were to escape. In such emergencies it is conceivable that a Canadian Coast Guard vessel could be required to remain on the scene as a communications centre during salvage or cleaning up operations.

A Marine Communications System covering the Arctic waters in the future should be one capable of providing solid coverage for radioteletype, C.W., voice and facsimile anywhere along the main Arctic Sailing Route from Alaska to some point within coverage of East Coast stations. To complete the network, it would of course be necessary that all shore stations in the system be equipped with radioteletype and the means necessary for the quick forwarding of marine traffic to southern destinations. Direct voice communications by duplex with ships anywhere along the Route would be a must for the type of emergency situations mentioned earlier and every shore station in the system should be capable of handling such calls. Lastly, the system should be capable of handling a volume of traffic such that it would not become saturated during peak periods or by extra traffic caused by emergency situations.

Future communications requirements in the North will, to a very great extent, be dictated by the amount of marine activities and the length of shipping seasons. As there have been no firm decisions made yet by potential exploiters of northern resources, it would be a bit premature to state future requirements in more definite terms.

Supporting Communications

A number of years ago the Ministry of Transport established a national teletype communications network primarily to support aeronautical operations. The network has been upgraded and extended over the years and a fully automatic computerized teletype network is scheduled for commissioning in September, 1970, replacing the present semi-automatic network. The network will interconnect all Ministry of Transport establishments having reliable landline facilities through a Montreal based computer. Delivery from any one point on the network to any other point in Canada will be almost instantaneous and well within a five minute delivery requirement for operational messages. The Canadian network also forms part of the world wide aeronautical fixed teletypewriter network. In addition to Air and Marine Operational traffic and Meteorological traffic, Ministry of Transport Administrative messages are passed over this network on a lower priority basis.

At the more northerly or isolated points the national network is extended by means of radio circuits. The Ministry of Transport is presently converting their radio circuits to either LF, RTT or HF SSB voice and/or RTT circuits. Where practical LF circuits are established using an existing

non-directional beacon for transmitting purposes. These transmitters operate at 400 watts although high power NDB's (2 KW) are utilized at Baker Lake, Cambridge Bay, Coral Harbour, Resolute Bay and Frobisher. The HF SSB circuits make use of 500 watt P.E.P. transmitting equipment.

The Ministry ofTransport have established base radio stations at Churchill, Baker Lake, Chesterfield Inlet, Ennadai, Resolute, Eureka, Isachsen, Mould Bay and Alert to provide communications for field and survey parties operating in range of these points.

In addition to the Air and Marine Operational messages Meteorological messages and MOT Administration messages handled on the computer network, other Government Departments' administrative messages and commercial messages may be handled on the radio circuits where no other communications facilities are available. This traffic is routed to the nearest landline interchange point where it is transferred to commercial circuits.

Meteorological Communications

Weather Observing System

The weather observing system of the Canadian Meteorological Service comprises a network of stations located at specified intervals throughout Canada.

Stations on the complete network may be operated by one or any of the following:

CON - Contract (with private person, corporation, etc.)
DND - Department of National Defence
ITCA - International Telephone and Telegraph Arctic Services, Inc.
JAWS - Joint Arctic Weather Stations (United States Weather Bureau/Meteorological Service of Canada).
MSC - Meteorological Branch, Department of Transport.
MAR - Marine Services, Department of Transport.
PCSP - Polar Continental Shelf Project.
TEL - Telecommunications and Electronics Branch, Department of Transport.
USN - United States Navy.

Stations located north of the 55th Parallel are either CON, JAWS, ITCA, MSC, TEL, or combined MSC/TEL and one PCSP.

As of March 1, 1970, the meteorological communications system was converted from semi-automatic operation to a computer controlled switching system. The system consists of a number of individual circuits, operating at 100 w.p.m. connected to a third generation Collins Model C-8500 computer, located at C.N.T. Headquarters in Toronto.

The teletype equipment, circuits and the computer switching equipment for the system are leased from CN/CP Telecommunications and sub-contractors such as Quebec Telephone Company, Alberta Government Telephones, etc.

An efficiency rating of 95% is generally considered as acceptable for Met. operation. Anything less usually results in complaints and the need for supervisory attention.

Ideally, all stations on the weather reporting network should be connected to circuits controlled by the computer, which allows data to be picked up direct and weather information fed to the station from the computer. Another advantage is that stations will obtain a hard copy of data required for meteorological support, by use of teleprinter equipment. However, it is recognized that this may not be economically feasible nor practical, particularly for stations located in remote areas. For these stations, the requirement is for suitable communications that will ensure the collection of data within the transit times of 10-30 minutes and the dissemination of data to the stations.

In regard to physical operational requirements it is desirable that failures or outages to any new northern circuits would be kept to the same minimum as that for regular landline. Garbling or error rate (as distinct from outages) is of importance in computer operation and in the transmission of a large amount of digital data containing symbols and numbers. Circuit assurance and parity checks are proving useful if only to indicate questionable sources. While there has definitely been improvement in northern communications, it should still be pointed out that weather information from this area is as much or more vital than that in other areas. Any new measures designed to upgrade reliability, accuracy and consistency in day-to-day communications to the north country would be invaluable.

In addition to the teletype system, the Ministry of Transport operates two separate and distinct facsimile systems, National/ Regional and Supplementary, for the transmission of weather charts by facsimile communication processes.

The transmitting stations to the National/Regional network are the national transmitting centre: Central Analysis Office (CAO) at Montreal and six Regional transmitting centres at: Halifax, Montreal, Toronto, Winnipeg, Edmonton, and Vancouver. (At certain periods of the year, Resolute and Frobisher may act as radio transmitting stations for ice information).

The Supplementary network has only one transmitting centre, CAO at Montreal. The transmissions on both networks are made to a large number of recording stations, with most of the stations under Meteorological jurisdiction, the remainder operated by Department of National Defence, government offices other than Transport, Provincial Governments, Universities and industry.

Most of the stations are located south of the 55th Parallel except the following:

Fort St. John
Yellowknife
Whitehorse
Frobisher
Inuvik
Resolute

The networks consist of a main trunk circuit, emanating from Montreal (CAO) and extending to Victoria on the West Coast and to St. John's on the East Coast. The main circuit is routed over the microwave facilities of the Telegraph Companies' landline circuit extensions to recording stations.

In addition to the landline circuit, two stations, Edmonton and Halifax, make a radio facsimile broadcast of the charts received to designated areas. The Edmonton radio facsimile broadcast is intended for reception by stations in the Arctic areas and ships operating in Arctic waters, equipped with facsimile equipment. The Halifax radio facsimile is operated by DND and is mainly intended for ships operating in the Northern Atlantic.

The landline circuits have a general efficiency rating of 90 to 99 per cent. For radio facsimile transmissions, the efficiency rating varies between 30 and 75 per cent.

The operation of a facsimile network at 120 rpm requires good quality circuits of voice frequency or better, with conditioning for phase delay and other conditions a requirement.

An operating efficiency of 95% or higher is desirable. When the rating is below 95% usually the quality of reproduction suffers, or the chart is not received resulting in requests for re-transmission. In view of the much lower percentage figures for radio facsimile reception, it would be desirable to have as many of the present radio recording stations converted to landline, or its equivalent, as possible.

Department of National Defence Requirements

A. General - A study is under way investigating and detailing the future tasks and roles of the newly formed Northern Region Headquarters (NRHQ). The results of the study will be presented for consideration in October, 1970. From this study, communications planning will evolve. Meanwhile, we can list the requirements which are known at this time and possibly forecast future trends.

B. New Requirements - The following requirements are known at this time:

(1) Fixed Locations

(a) Yellowknife, NWT - This is the location of a Canadian Forces Liaison Detachment. This detachment is serviced by local telephone service and has access to a Telex terminal operated by another federal agency. The NRHQ will be relocated from Ottawa to Yellowknife by November, 1970, and will require the following service at that time:

(i) Teletype: DND provided terminal equipment with a 60 w.p.m. commercial line from Yellowknife to Edmonton, Alberta. This terminal will operate as a detachment of the Canadian Forces Communications System on an eight hour, five day per week basis with a full-period capability when required.

(ii) Telephone: A 10 line, 50 local PABX with direct-in-dialing capability will be required for local service. Long distance voice service to selected locations in the South and to communities in the North will be required. An accurate forecast of long distance traffic volume is not possible at this time, however, an estimate of two outgoing and two incoming messages per day would appear adequate for planning purposes.

(2) Whitehorse, Y.T. - This is the location of a Canadian Forces Liaison Detachment. This detachment will continue for the next year at least to be serviced by local telephone service. An estimated message volume of one outgoing and one incoming message per day exists at this detachment. At this time this traffic is being handled through another government agency.

(3) Mobile Land and Air Units - These units operate out of permanent bases in the South. When deployed on tasks or exercises in the North, they will provide their own radio communications to NRHQ and their southern bases. Requirements will occur for local telephone and/or teletype service at advance bases or airfields in the North to support these mobile units, however, no firm requirement can be forecast at this time.

(4) Canadian Rangers - Detachments of the Canadian Rangers exist at virtually every settlement North of 55^{o} latitude. While routing communications between NRHQ and each detachment will only average one telephone call or message in each direction per year, it is imperative to our national security that quick emergency communications be established between these detachments and NRHQ Yellowknife when required. Since the volume of traffic cannot justify full time service to each of these detachments,DND will be dependent on the assistance of other federal agencies and commercial concerns to provide communications in time of civilian or military emergency.

C. Future Trends - While it is safe to forecast increased military interest and activity in the North, it is too early to predict what form this activity will take. Two of the more likely areas of military activity that would affect northern communications are the following:

(1) Search and Rescue - This task could be carried out by military units either permanently sited in the North or units deployed as required from the South with a small headquarters and communications detachment permanently located in the North. In either case the permanent site for such a unit would be associated with a large airport/ DOT facility such as Yellowknife or Inuvik and would be capable of providing emergency surface and ground to air HF (SSB) communications throughout the North.

(2) Northern Region Detachments - Depending on the scope and direction of military activities in the North it is possible that NRHQ will deploy several small (three to five men) permanent detachments. These detachments would be responsible for such things as liaison with local government and civilian agencies; ground search coordination, coordination of local Ranger activities and providing an advance base and other assistance to mobile ground and air units from the South. These detachments would require voice communications (telephone or radio) to all government and commercial agencies within their local area of responsibility and both voice and teletype communications to and from NRHQ Yellowknife. These local detachments could be located in any or all of the following communities:

(a) Whitehorse, Y.T. - Present Canadian Forces Liaison Detachment.

(b) Inuvik, NWT. - Associated with Canadian Forces Station, Inuvik.

(c) Alert, NWT. - Associated with Canadian Forces Station, Alert.

(d) Frobisher Bay, NWT- At present a detachment from Maritime Command, Halifax.

(e) Resolute Bay, NWT - Possible site of Canadian Forces Liaison Detachment.

(f) Churchill, Man. - Possible site of Canadian Forces Liaison Detachment.

HUDSON BAY SYSTEM

The Hudson Bay Company radio system is an extensive one. Comprised of seventy-five stations, it is represented in the North of all the provinces, and in the Northwest Territories, including the Arctic Islands.

The system was established to provide an administrative link between the Hudson Bay Company's stores and administrative centres in Edmonton, Winnipeg and Montreal.

However, use of the network to relay messages for government and commercial groups is substantial and growing. This "outside" traffic is relayed to the nearest commercial outlet in accordance with Hudson Bay Company licence provisions. These

outlets include the Department of Transport, the Canadian National Telegraph , and several telephone companies.

A charge of $1.50 for 50 words (25 cents for each additional 10 words) is levied over and above the phonogram or telegram rates that may apply. A daily schedule is observed of two to three transmissions daily, with the public commercial radio outlet concerned.

RCMP SYSTEM

The RCMP own, operate and maintain their HF radio system and provide for 24 hour operation where necessary. Their radio system is operated primarily as a point-to-point communications service. In northern Canada, and less densely populated areas, where due to vast distances involved, VHF-FM mobile radio range is insufficient, HF radio is also used as the main mobile communication service. The RCMP system, apart from its use for carrying administrative traffic for the Force, is also the most reliable emergency system available covering the North. Reliability is very high because stations can work between each other and do not necessarily have to home onto a particular base station . By relaying messages between adjacent locations it is possible to communicate quickly though indirectly between two points.

Volume 3 of Telecommission Study 8(c) contains a detailed listing of all stations operated by the Hudson Bay Company and by the RCMP. It is apparent that both these agencies would be able to use more reliable service provided by terrestrial or satellite means if such service could be made available on economic terms. This is particularly so in the case of the Hudson Bay Company who permit the public to make use of their system for a small charge. Since the RCMP system is a very effective and reliable system for the use of the Force it is unlikely that this agency would be quite so anxious to curtail their own operations.

CANADIAN BROADCASTING CORPORATION

The first two contributions to Telecommission Study 8(c) entitled "Communications in the Canadian North" and Catalogue of Communication Systems in Northern Canada" describe those facilities which are presently available in the North for the transmission of television and radio services. It can be seen there is no transmission capability for bringing live television to the Yukon, Northwest Territories, and northern parts of the Provinces generally above the 55° parallel. Network radio service

does not reach the District of Keewatin, Baffin Island, or the Arctic Coast. Many communities in the northern parts of the Province are similarly not connected to the CBC radio network. Those locations lacking live television and medium wave radio network service are listed in the Tables at the end of Volume 3 of Telecommission Study 8(c)-3.

Radio

It is clear from the recommendations of the Yellowknife Communications Conference that the first requirement is for each community to have its own broadcasting station. This station might be a low-power radio transmitter to be used for education, information, entertainment, and social action purposes.

The second requirement is for these stations to be connected intra-regionally, inter-regionally, and finally to the national radio CBC network.

Presently, the CBC operates two networks in the Territories - the Mackenzie and the Yukon networks. The Yukon network consists of stations at Fort Nelson, Watson Lake, Swift River, Cassiar (B.C.), Teslin, Whitehorse, Haines Junction, Destruction Bay, Beaver Creek, Dawson City, Carmacks, Mayo, and Elsa. The Mackenzie network has stations at Hay River, Pine Point, Fort Smith, Uranium City (Sask.), Fort Providence, Yellowknife, Fort Simpson, Wrigley, Fort Norman, Norman Wells, Fort Good Hope, Inuvik, and Fort Chippewyan (Alta.). Both these regional networks broadcast, in addition to regular CBC programs, programs in Eskimo, Chippewyan, Slavee, Cree, and Loucheuse.

The following requirements have been identified for the extension of network radio service.

(a) Extension of the Mackenzie network to the eastward to cover the Western Arctic - with Inuvik as the program centre.

(b) A new regional network established to cover the large Indian population of Northern Manitoba - possibly from a program centre at The Pas.

(c) A regional network originating at Churchill to cover the Keewatin communities.

(d) A French regional network to cover communities on the Labrador Coast.

(e) Extension of the Labrador network to cover communities on the Labrador Coast.

(f) A regional network for the East Coast of Baffin Island and the communities on the Arctic Coast.

Television

The Eskimo and Indian people of the North have not so far expressed a priority need for the reception of television programs in their communities. Their main concern, if live television is brought to them, is that the program material should be suitable for their culture and education. However, it is probable that the younger generation of native people will respond to television if the problem of programming can be solved.

The need for live television has been stressed by northern residents who have come from the south, and particularly by industry, to encourage longer turn-arounds of labour forces. The requirement for live television is evident in those communities having Frontier Package Service because delayed programs have not been well received.

No community in the Yukon or Northwest Territories has live television now. It appears that the priority at the moment is to serve large, particularly industrial, centres. Since industrial development in the Yukon and the western part of the Northwest Territories is far ahead of the Central and Eastern Arctic, it is likely that live television will be brought to these areas first. But television can be a potent instrument for education and would be most effective for this purpose if programs were originated in the North - say Yellowknife.

TERRITORIAL GOVERNMENT ADMINISTRATION

A statement of requirements would not be complete if some mention were not made of modern communication techniques to assist government administration.

The use of communication as an instrument of government has not been exploited very intensively. The present reliance is on telephone with short wave radio for work in forestry. A great gain in efficiency might be achieved by print-out equipment, facsimile units for police identification, central filing of records and claims without the need for outlying offices or expensive journeys to urban points and also for

recording, storage and retrieval of land titles, company records, chattel mortgages, etc. Some legislative changes might be needed but the Land Titles Act and Companies Ordinance are long due for overhaul. The federal government could consider the possibility of up-dating Territorial administrative methods as a pilot project in the governmental use of modern computer and communication technology. Car Licences, vehicle records, business licences, game licences, fishing licences, and all the statistical studies to evaluate the economic and sociological health of the area all involve detailed procedures which should lend themselves to programming.

CHAPTER IV

Northern Communications Conference

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NORTHERN COMMUNICATIONS CONFERENCE

A Northern Communications Conference was held in Yellowknife, N.W.T. between September 9 and 11, 1970. This Chapter records the purpose, oganization, and recommendations of the Conference.

The Northern Communications Conference provided the first opportunity for the people of the North to be heard on a variety of communication topics and issues. It enabled them to express their views and present their needs for communication services. About 200 people attended the Conference. They came from all parts of Canada, some came from remote and isolated parts of the North, others from the major southern centres. Involvement by native participants was articulate and sustained. Representatives of government, industry, universities and the professions came primarily to listen and obtain direct experience of the northern environment. A distinctive feature of the Conference was contact and surprising unanimity on communication priorities by peoples of different cultures and disciplines.

The Conference was intended to focus attention publicly on the relevance of communications to northern needs and aspirations. Active participation was encouraged and information sought to guide and affect policy formulation. The expectation was that the unusual blend of experts from the social and technological sciences would respond to communication problems and produce recommendations that were imaginatively conceived to stimulate future action.

CONFERENCE ORGANIZATION

Initial meetings to discuss the holding of a Conference on Northern Communications were held in the summer of 1969 and involved primarily government officials. By the fall of 1969 a commitment had been taken by both the Department of Communications and the Department of Indian Affairs and Northern Development to share the financial expenses of a Conference on Northern Communications, and a number of academic groups were contacted with respect to sponsoring the meetings and organizing its program. By the autumn of 1969 a program committee composed

of officials of the Department of Communications, the Department of Indian Affairs and Northern Development, the Boreal Institute of the University of Alberta and the Arctic Institute of North America met in Ottawa. A Liaison mechanism with both the Northwest Territorial Government and the Yukon Territorial Government was established.

From the outset it was decided that the Conference should be held in the North, that it should look at the problem of communications in its widest aspect, both technical and sociological and that it be structured so that those attending could participate fully. The format finally established was to break the Conference into six half-day sessions with the first three being considered basically as information type meetings with papers to be presented and discussed. This would be followed by two sessions of workshop discussions where participants of the Conference would analyze the information and put forward their own ideas. Finally the Conference would meet for a plenary session to discuss the results of the workshop.

The organization of the Conference provided for the circulation of articles and papers prior to the meeting, and their presentation in synoptic form by their authors. Panel Sessions were arranged for the purpose of (a) exploring what telecommunication facilities exist and identifying particular areas of communication needs, (b) reviewing technological options for improving northern communications and (c) assessing the implications and impact of communications on the social and cultural life of the northern residents.

SPECIFIC RECOMMENDATIONS

1. There is an urgent requirement to provide reliable two-way telephone and teletype services to remote communities in the Territories and northern parts of the Provinces. The prime need is for telecommunication facilities to support essential health and emergency services. Priority must be given to establishing telecommunication links between remote communities and centres where hospitals are located, e.g. Frobisher Bay. The northern residents want good facilities for:

    a) intra-regional communications
    b) inter-regional communications
    c) local exchange connections

   This reliable service should be available to permanent communities having populations greater than 25 or 50 on a 7-day 24-hour basis and not be subject to outages due to climatic or

other natural variations. Reliable telephone and teletype services are also required by Territorial and Provincial Governments and by federal agencies for administrative purposes. A teletype circuit is essential for administration when the community has more than 300 people. More sophisticated services (medium and high speed data) should be provided where demand is indicated by commercial agencies.

The situation generally is that existing point-to-point services are inadequate and that problems are particularly acute in the District of Keewatin, Baffin Island, and the Arctic Coast. High frequency (HF) radio as presently operated does not meet required levels of service.

2. Radio broadcasting is very important to northern residents. Presently there are large areas, such as the District of Keewatin, without broadcast services. Each community should have a radio program service for education, information, entertainment, and social action purposes. This service might be established by low-power community operated radio stations. Programming in native languages should be encouraged. Full participation and operation by local people is recommended. Community ownership - as distinct from CBC overlap - should be investigated. Consideration should also be given to higher-powered AM broadcasting stations to serve complete regions. Relaxation of regulations and technical standards to permit the use or development of low cost equipment should be encouraged if this does not interfere with public safety and convenience. The stations at Churchill and Inuvik provide a service that could be used as a precedent for other areas.

3. Low power community broadcast stations should be connected intra-regionally, inter-regionally, and to the national radio CBC network. Northern orientation of programming is essential. Radio network service is presently unavailable in the Central and Eastern Arctic and along the Arctic Coast. The CBC short wave service is unreliable and subject to long outages due to fading. Steps to improve this service should be taken. Radio coverages should be available to everyone as the essential means of mass communication in the North. The CBC Northern Service should be established in the North (perhaps at Yellowknife) and be given full program control including choice of what it wants from the national network.

4. Nomadic or hunting groups should be provided with low cost radio units to contact their resident community in emergency or other urgent situations. Special equipment may have to be developed for the purpose and have incorporated a homing device in addition to voice capability. A task force of technologists

and users should be formed as soon as possible to pursue this concept. The equipment should be inexpensive, portable and rugged for Arctic conditions.

5. More extensive use should be made of technology for educational and social development purposes. Services such as video tape recorders (VTR), films, sound cassettes, and records are flexible and economical. Video Tape Recorders are particularly valuable and should be widely distributed for local use. They can be used effectively for group-interaction discussions and for recording community news and events for subsequent presentation to government legislators and staff. Video tapes can be exchanged between communities for regional dissemination of news and affairs. Regular air lifts of video and audio tapes should be considered. Each community should have trained personnel for the necessary maintenance of equipment. Primary power sources within communities are required. Video Tape Recorders might be installed in isolated communities as part of a pilot study to aid in establishing program requirements for regular TV service.

6. Live television and Frontier Package Coverage service should be extended to more communities in the North with programming suited to the northern needs. This may mean an additional channel on ANIK to ensure:

   a) that the transmission medium exists for carrying northern network programming,

   b) the feasibility of programming originating in the North (possibly Yellowknife) can be developed. It is recognized also that the availability of live television could stimulate industrial initiatives.

   Concern is expressed by native people that programming designed for southern audiences would distract and disturb their culture. It would also widen the generation gap between the older traditional groups and the younger people who have been exposed to the southern way of life.

7. The attitude of some northerners is that the ANIK satellite falls short of their expectations in that all their immediate needs will not be met. It is recommended that funds for the expansion of ground systems in the North must not be prejudiced by expenditures for the ANIK satellite which is designed to benefit all Canadians and not just the northern residents.

8. There was interest expressed in direct broadcasting to home receivers and the advantages of the technique in education. Research should be actively pursued to realize the potential of satellite communications for this purpose.

9. The common carriers should give adequate preventive maintenance service on a routine basis. A long range programme should plan at giving education to northern operators so that they can become permanent maintenance men in the North; interest in amateur radio clubs should be fostered.

10. A pool of portable equipment should be made available in every settlement to be leased or loaned to all trappers and others who are leaving the settlement and are going on traplines to permanent camps, oil sites, etc.

11. An inventory be compiled of radio frequencies in use, systems, equipment, and purpose in northern Canada so that services can be optimized and duplication eliminated.

12. The Postal Services in the North are too slow and deliveries proceed by extremely indirect routes. This service is very important to residents and improvements are required.

13. Attention should be given to communication at the interpersonnel level. This means direct communication between white and native people. Sensitivity training can help close the gap between the "haves" and the "have-nots".

GENERAL OBSERVATIONS

Many far-reaching and general observations on northern communications were made during the Conference. It should be appreciated that they were not all discussed in the Plenary Session, and were not necessarily endorsed by all attendees or the sponsoring organizations.

Northern problems have now reached the point where they require much more urgent and national attention. The pace of change is rapid and it may be necessary to allocate more resources to meet this situation. Improvements in northern communications will require large capital investment. Action is required to respond to four pressures -

(a) Commercial development particularly by oil and gas industries will produce massive needs for transportation and communications. These needs will materialize in the next few years.

(b) The communications needs of native people in the North have not been adequately taken into account. The result is that they are not realizing their potential or full capability.

(c) The increased interest in Canadian Control and surveillance of the North places importance on the availability of adequate and reliable communications capability. This includes areas in a marine region 100 miles off the Arctic Coast and internal uninhabited regions such as the District of Keewatin and the Archipelago Island.

(d) The advent of communication-satellite and the launching of ANIK provides the instrument for serving the North with reliable communications both for general telecommunications and broadcast services.

2. The Department of Communications should assume over-all planning responsibility within the federal government for northern communications and it should have a special northern group for the purpose. It is recommended that a Task Force be established in the Department as soon as possible. The group should be multi-disciplinary with initial responsibility to -

(a) Establish liaison with native associations, settlement leaders, consumer groups, and the people so that the areas of concern and the order of priorities for communications can be determined. Opinion surveys should be carried out using modern techniques such as video and audio tape recordings.

(b) After listening to the communication requirements the Task Force should set goals and objectives for improving northern communications.

(c) Inform northern residents of advance planning affecting them so that any necessary adjustments can be made. Northerners should be given full information on options through conferences, seminars, and through personal contact. Members of the Task Force must travel extensively in the North. At certain times Plenary meetings should be held where regional representatives can meet with government officials.

(d) Arrange for native groups to be advised and given information in their own language telling them how to formulate their communication needs. Booklets or brochures would be helpful. They would identify what

steps are to be taken in requesting extended telephone or broadcast coverage. A public relations program might be initiated to explain to northern people the purpose and role of agencies such as DOC, CBC, TCTS and CNT. Application forms and their completion should be explained where necessary.

(e) Follow-up recommendations of the Yellowknife Conference by determining research needs so that the necessary programs of study can be delineated and sponsored.

(f) Ensure that factual and easily understandable information is made available on Telesat's satellite - its role and the services it will bring to the North.

(g) Stimulate continuing activity so that the impetus and interest created by individuals at this Conference is maintained.

3. It is recommended that an Institute on Northern Communications be founded to study all forms of communications, both technical and social. This body would be equipped to respond to hearings of public bodies, to prepare and submit briefs, and to carry out research in establishing communication needs. It should be staffed with full-time native researchers and should be located in the <u>North</u>, not in southern universities. It should also be given an ample budget for travel throughout the North. It would work in the areas as described above for the Task Force of the Department of Communications and in addition -

(a) Investigate the possibilities of programming in Eskimo and Indian languages for widest coverage and communication, and further the attainment of uniformity in language among groups using different dialects.

(b) Prepare five-year programs to establish the requirements and priorities to meet the objectives of the Institute.

4. Until the necessary machinery is available, northern residents with communications problems should channel them through native spokesmen, nurses, teachers, RCMP, missionaries, etc. who in turn would convey their message to the regional administrators. Then the information would be passed along to the proper authorities in territorial, provincial and federal government departments.

5. The North, in terms of communication requirements, means not only the Yukon and Northwest Territories, but the northern parts of seven of the Provinces. Ten levels of government are involved. Lack of administrative unity must be compensated for by a dialogue between governments. The juxtaposition of systems or networks cannot achieve the desired result of a total communications facility. There must be cooperation and coordination between the different levels of government if available services are to be optimized.

6. Communications policy must be consistent with overall national policy and objectives for northern development and the general trends of economic development. It appears that the North will change rapidly in the next decade both economically and demographically. Relatively large urban centres will form at the centres of resource activity and the smaller northern settlements will disappear. The importance of good north-south communication is stressed to accelerate industrial development.

7. Federal policies should be relaxed to permit Provincial and Territorial governments, municipalities, and northern communities to establish their own northern broadcast stations. Since the establishment of local community broadcast stations will require federal funding, the Department of Communications might provide aid and make the necessary regulations and controls.

8. Northern participants should in future be given more time to prepare for communications conferences and their representation should be increased. There should be more time for general discussion - questions from the floor do not constitute a dialogue in a way that native people find satisfying.

CHAPTER V

General Information and Broadcasting Services.

CHAPTER V

GENERAL INFORMATION AND BROADCASTING SERVICES

Most northern communities lack proper broadcasting and information services. This renders a harsh environment more inhospitable. A Royal Commission on Broadcasting has said that the North is not only silent but forgotten. But at last the technological means are becoming available to bridge this communications void. Before policy and financial commitments are made it is essential to determine northern communication needs and the best mix of technological choices to meet these needs.

It is interesting to look at the North as a consumer of total communication services. Rather than looking at different media choices in isolation it is tempting to enquire if an approach which considers all information sources and their interaction would be helpful in the northern context.

SOCIAL POTENTIAL OF COMMUNICATIONS

The potential of communications for social development in the North has not yet been grasped and pursued. The physical and psychological isolation of living in the North cannot be truly appreciated by a non-resident. If permanent settlement in a number of relatively large communities is to be achieved then the communication amenities of the South must be provided.

The native people need access to communications for their education, training, and the maintenance of their own cultural heritage. They must be able to reach out to adjacent communities, which are separated by great distances, to talk and keep in touch with their families and friends. Their integration into the main stream of the Canadian milieu will be difficult. It may involve their re-settlement or travel to the large northern centres such as Yellowknife and Frobisher Bay. This transition can be helped if they and the people left behind in the smaller settlements are not to be separated by both distance and silence.

The ownership, provision, operation, and maintenance of communications facilities offers a fertile field for native employment, expression, and development. Vocational schools are beginning to turn out native technicians who are ready for employment in the communications field.

COMMUNICATION NEEDS

There are two areas of communication needs in the North. First, there is a requirement for telecommunication services to permit point-to-point communication between communities. Telecommunication facilities for this purpose are functional and serve for the conveyance of messages by the public, industry, and government agencies.* Beyond this basic need there is a requirement to provide communications of the type mostly identified with broadcasting; but more precisely, this communication need covers the spread of information of all types in the oral, visual, and written form.

The North, to be kept adequately informed, must have access to all means of communication. This includes radio, computers, video and audio tapes, records, and even gossip. It is useful to review the availability of information sources in the North to appreciate the magnitude of the challenge that access to new or improved service entails.

1. Radio

The first and most basic means of mass communication in the North is radio. Radio broadcasts are of prime importance to people living in small isolated communities scattered over a vast area with few newspapers and little entertainment. It provides them with information on weather, road and flight conditions, health, fire and flood warning, entertainment; and community, regional and national news and comments. The only problem is that it is not always available. The following requirements have been identified for the extension of network radio service on a geographical basis in the North:

(a) extension of the Mackenzie network to the eastward to cover the western Arctic - with Inuvik as the program centre;

(b) a new regional network to cover the large Indian population of northern Manitoba - possibly from a program centre at The Pas;

(c) a regional network originating at Churchill to cover the Keewatin communities;

* Telecommission Study Volume III - Northern Communication Requirements.

(d) a French regional network to cover the eastern shore of Hudson Bay and northern Quebec;

(e) extension of the Labrador network to cover communities along the Labrador Coast;

(f) a regional network for the east coast of Baffin Island and the communities on the Arctic Coast.

2. Television

The capability to transmit television does not exist in the Yukon or Northwest Territories, or in many areas of the northern parts of the Provinces now. It should be noted that the Eskimo and Indian people of the North have not so far expressed a priority need for the reception of television programs in their communities. Their main concern, if live television is brought to them, is that the program material should be suitable for their culture and education. However, it is probable that the younger generation of native people will respond to television if the programming problem can be solved.

The need for live television has been stressed by northern residents who come from the South, and particularly by industry, to encourage longer turn arounds of labour forces. The requirement for live television is evident in those communities having frontier package service because delayed programs have not been well received.

3. Information Services

Survey trips to many parts of the North have indicated that there is an unstated but definite need for educational and information facilities such as films, books, video and audio tapes, newspapers, and prompt delivery of mail. No attempt has been made to ensure that these amenities are systematically distributed throughout the North.

Another area that should not be ignored is the need for telecommunication systems to allow the people of the North to communicate with each other intra-regionally. What is needed is simply a type of gossip network that provides an information need that is not met by normal telephone or teletype communications.

POSSIBLE SOLUTIONS

The possibility of improving and consolidating various northern communications services is discussed below.

(1) Radio

Two essential needs are to establish the means for local or community programming and to bring network services to northern settlements.

Community Broadcasting Stations

Volume 4 of the Telecommission Study contains a detailed scheme for establishing low power broadcasting stations in the North particularly in the High Arctic, for those communities not served by medium band stations of the CBC Northern Service. The stations would be operated voluntarily by the people of the community to broadcast programs of information and entertainment in the local language. The station would keep in touch with the 'outside' by means of the CBC's Northern shortwave service, particularly its news and messages in Eskimo. The stations would circulate their own programs on tape among themselves. The CBC's role in this scheme would be to train operators, advise on technical equipment, supply programs if requested and help the stations circulate their own taped programs. The government would buy the equipment and pay for its installation; the community would pay for its upkeep. Besides its effect on community development, the project would have a spinoff in familiarizing native peoples with the use of electronic equipment, a skill which could be useful to the young seeking work'outside'.

Network Connections

The establishment of community broadcasting stations leaves two open questions (i) how can the isolated local community stations be network connected, and (ii) what can be done about the existing CBC Low Power Relay Transmitters (LPRT) that are network connected but have no local injection option.

There is the problem of connecting local or community broadcast stations, as discussed in Chapter III, to regional and national radio networks. The reason why many communities of sizable populations are not connected now is that the transmission capability for carrying the radio programming simply does not exist. The ANIK satellite offers a solution to this problem. It was noted in Volume 3 of the Telecommission Study that point-to-point communications for

telephony and data services are the first priority for improved northern communications. In areas of the North such as the District of Keewatin, Baffin Island, and Arctic Quebec, the satellite may have to be used as the only economic way of bringing reliable radio communications to isolated communities.

Some consideration has been given in Volume 6 of the Telecommission Study to the installation of small earth stations capable of transmitting one or two telephone channels to the master station at Toronto. If it is decided to proceed with these stations, it is an incremental cost to ensure that each small earth station also has the capability to receive a radio channel. It cannot be overemphasized that a radio program channel to these communities should be provided at the same time that provision is made for general communications services.

There is also the problem of originating broadcasts from the North. There is no reason why the transmit telephony channel at the small earth stations should not be used for originating program material occasionally from remote communities in the North. Of course, the quality would be degraded since the bandwidth would be in the order of 4 KHz instead of 8 KHz for standard broadcast quality. But since local broadcasts from small communities would not take place very often this would be tolerable.

Local Programming on LPRT Stations

Presently the CBC LPRT stations are network connected without the means for the local injection of community news, information, and entertainment. There are a number of northern networks connecting LPRT stations but the program origination is at central points. As an example the Yukon network consists of stations at Fort Nelson, Watson Lake, Swift River, Cassiar (B.C.), Teslin, Haines Junction, Destruction Bay, Beaver Creek, Dawson City, Carmacks, Mayo, Elsa, and Whitehorse. All the programming emanates from Whitehorse and the capability does not exist for the other communities to inject their own local affairs for the benefit of people resident in these communities. Local information of a parochial nature is not of great interest for network distribution. A combination of network and local community broadcasting would be ideal.

This suggestion has policy and financial ramifications. The CBC LPRT network was established to keep costs to a minimum while providing a reasonable quality of broadcast services. The suggestion that local injection at the community level be permitted requires a change in operation of the LPRT network. The stations would have to be manned during the local broadcasts and small studios would be required to house the equipment for broadcasters. But a few local

communities are in a position to build or maintain their own studios and arrangements could be made for them to share the LPRT services. This might require agreement between the Community Council or other elected bodies and the Canadian Broadcasting Corporation.

Approval would also be required from the Canadian Radio-Television Commission to permit the changed operation of the LPRT networks.

One of the factors in support of a combined Community-CBC operation is that the need for native organizations to establish their own private networks would be avoided. There is no doubt that the pressure for private networks will intensify unless action is taken to provide a public network by the CBC that is responsive to native needs and aspirations. This alone might be sufficient to counter arguments that the cost of adding local injection to LPRT networks is prohibitive.

Short Wave Service

The CBC operates a short wave service to the North which, in the view of many northern residents, does not provide sufficient and reliable coverage. The suggestion has been made that attempts be made to enhance the signal level of short wave broadcasts and to use the service itself as a more effective medium for serving the North.

(2) Television

It will be some time before direct broadcasting of television signals can be received on home receivers. Until then the programs transmitted by ANIK will have to be picked up by ground receiving stations for broadcasting on a local television station. Only those with home receivers within the broadcast area of the local television station will receive the programs. Present planning is to establish earth receiving stations at all northern communities presently served by frontier coverage package service. In this way the majority of the people in the North will be served; although this means that there will be a concentration of earth receiving stations in the Yukon and western parts of the Northwest Territories.

Service by satellite will introduce programming problems. The northerners have indicated that they are not content to receive television programs produced for the people of Toronto, Winnipeg, or Vancouver. The native peoples consider these programs of doubtful value. If the television service is to meet the needs and wishes of the people of the North, native-born Eskimo, Indian, Metis, and White, as well as the transient population, it should be a mixture of local regional, and national programs as provided by the CBC in other regions

of Canada. The way to meet this northern regional need is to use one channel of ANIK especially for this purpose. A production centre for northern programs might be established in the North to transmit programs to the satellite for distribution.

It would appear that the most logical place for this centre would be Yellowknife. Yellowknife is on Mountain Standard Time, which is the medium zone of the five time zones in the North. It would be a convenient centre for receiving programs shipped from other stations of the northern service - Whitehorse, Inuvik, Churchill and Frobisher Bay. These stations should have a limited capacity to produce local video tape programs to ensure that Yellowknife and the Mackenzie District did not monopolize programming in the North.

(3) Information Services

Several trips to Labrador, Baffin Island, the Arctic Coast, Keewatin District, the Yukon and the Mackenzie Delta region indicate that there is a need for educational and informational facilities such as films and video tape recorders (VTR). The availability of a film service would provide many dividends. It is apparent that films of any kind, when shown to northern audiences, receive enthusiastic response. It is important that the community rather than a teacher or entrepreneur should decide the type of films to be distributed between communities. Selection has to be done through consultation with community leaders and Councils. An attempt should be made to reach all residents with material of direct interest to them.

Package programs could also be made available on video tape. This is particularly important for educational purposes. Prepackaged lessons and information programs could be made available and exchanged between communities. These programs could be supplemented with printed lessons or followup material as suggested for radio. This medium might prove to be an improvement over radio because of the possibilities of visual presentation and repetition of the material.

Considerable work could be done on the dissemination of a wide variety of books on a broad range of subjects. It is clear that in the school libraries visited in northern communities, there are not sufficient books to interest all adults and many of the children. The best service would probably be by air.

Departments of education could make more use of educational technology both in schools and in the general community, particularly radio, TV, VTR, and sound cassets. Each community could regard the school as a community centre, equipped with a range of resources such as books, pictures, slides, cassets, records, etc. The educational

experience must be made more flexible, less confined to the class room, making more use of the general environment.

Regional production and distribution centres could be created to serve educational needs, perhaps in cooperation with southern university centres. Also research in specific problems could be undertaken with cooperation between northern communities and southern research facilities.

Of particular importance to an adequate total information service is the need to present material on preventive medicine. In many regions with small isolated settlements provision of medical care is of necessity a communication and transportation problem. An educational program of preventative medicine by dissemination of literature, VTR programs, or by radio, would serve an invaluable purpose.

The importance of using native languages is stressed so that families can keep in touch with each other. It is oral communication that is so essential. In addition, educational, economic and linguistic patterns must be kept in mind. Appreciation must be taken of the variety of native dialects. The dissemination of programs of Eskimo and Indian languages could go a long way towards introducing an element of uniformity in language across the North. Some consideration should also be given to the need for communities to communicate with each other outside conventional telephone connections. This possibility is explored in Volume 4 of Telecommission Study 8(c), where a scheme for training native radio amateur operators is proposed.

(4) Computers

Experiments have been undertaken by the University of Western Ontario to provide computer assisted education courses at Inuvik from a central computer in London, Ontario. The possibility of using the computer for educational purposes and for information retrieval requires reliable transmission networks. This means that the Eastern and Central Arctic cannot make use of these facilities. However, communities equipped to receive telephony by satellite could be easily adapted for this purpose.

INTEGRATED INFORMATION AND BROADCASTING SERVICES

There are possibilities that have not yet been explored for the integration of broadcasting and information services of the types discussed above. There is the thought that program tapes, either audio or video, could be distributed around communities in the North

after they have been used for regular programming. The northern service of the CBC presents many programs over the northern network which could be sent around communities if suitable arrangements were made. Each community would need playback apparatus. The use of program tapes would be a valuable tool for educational purposes. Cooperative arrangements between the CBC and the Territorial Government might be encouraged. Another possibility is that communities could generate material on video tape which could be suitable for transmission by the CBC at a later date. This might be a cheap source of program material for northern broadcasting.

CONCLUSIONS

An integrated approach to the use of information media offers perspective, and perhaps direction, to the evolution of northern communications. It might offer a framework for the planning of telecommunication services and ensure that social needs are fully taken into account in the planning process.

Particular emphasis is given to the use of broadcasting as an instrument of social and educational development. This may be a utopian premise since it has largely failed in this role in southern Canada. But the situation in the North is different because the indigenous northern residents need special programming to realise their potential and aspirations.

Three factors combine to make the possibility of a total approach to northern communications thinkable. First, the increasingly important role of the Territorial Government offers a focus for coordinated action. Second, the recently created Department of Communications can act as a federal catalyst to stimulate northern communications on a broad front. Finally, transmission capability will shortly exist to extend voice, data, and television services to the North at high, but incremental, costs.

ANNEX TO CHAPTER V

NATIVE BROADCASTING AND INFORMATION NEEDS

The Canadian Metis Society, National Indian Brotherhood of Canada, and the Indian-Eskimo Association of Canada, presented a brief to the Special Senate Committee on Mass Media in December, 1969. Extracts from this brief concerning broadcasting and general information services are contained in this Chapter to ensure that a direct statement by native people themselves is included in the Telecommission Study.

Radio, Television and Films as a Means of Producing Social Change

1. Radio and television, together with films, can be effective agents of social change. Broadcasting, particularly television, is the most powerful influence on public opinion and social attitudes since the invention of printing. Broadcasting can be used as a two-way channel, sending information to the public and receiving the public's response in return. Properly used it can make the individual more articulate today than he has ever been in the past.

2. It can be of particular value in communication with the poor, most of whom lack the heritage of a literate education. Their communication is oral. Radio and television provide a natural means of communication for them. Broadcasting, properly used, can help promote the social changes needed to bring native peoples into the mainstream of Canadian life and their heritage from the past. Their traditional culture has been and continues to be destroyed by the impact of modern technology. A part of that technology - broadcasting - can help to restore the balance.

3. At present, Canada's broadcasting system does not serve as an agent of social change. It is more concerned with upholding the existing social order. It is oriented towards the middle class, the consumers - the people who buy the goods its advertisers have to sell.

4. In the past the CBC produced notable programs that resulted in social and political action. In the '40s, its daily farm broadcasts and weekly Farm Radio Forums were pioneering ventures that gave the farmer a strong voice in national affairs and in the '50s, the French Network's public affairs

broadcasts articulated the quiet revolution in Quebec.

5. More recently it has broadcast some excellent programs on poverty in Canada, including some on Indians, Eskimos and Metis. But these programs have been on an occasional and fragmentary basis, produced for middle-class audiences from the point of view of the outsider looking on. They act as an emotional catharsis to the troubled conscience of the affluent and serve as a substitute for action. They are not designed to promote social change. To do so, they would have to be produced on a regular and continuing basis.

6. The National Film Board was set up with similar aims to the CBC: "to initiate and promote the production and distribution of films in the national interest and in particular .... to produce and distribute and to promote the production of films designed to interpret Canada to Canadians and to other nations". It has been more enterprising than the CBC in producing films to promote change. In cooperation with the Company of Young Canadians it trained and equipped a five man Indian film crew that has produced three films with an Indian perspective. This is part of its series of films entitled "Challenge for Change", whose purpose is 'to improve communications, create greater understanding, promote new ideas and social change'. It has also cooperated with Memorial University in St. John's, Newfoundland, in a project designed to help the citizens of the isolated fishing community of Fogo Island to adapt to a changing economy. There is need for much more activity of this sort from the mass media.

WHAT OTHER COUNTRIES ARE DOING

1. Broadcasting is being used to promote social and economic development in other countries.

2. Both India and Japan have tele-clubs, with feedback after each program. Follow-up activity is usually developed spontaneously by the clubs and serves as democratic training in citizenship.

3. AIR (India) broadcasts 15000 hours of programs from 30 stations especially prepared for the villagers. It arranges to supply radio sets for the community centres in the villages. There are 25,000 radio forums in India with two-way broadcasting that stimulates free discussion.

4. In Japan television sets are placed in community centres and schools in isolated farming villages. Adult education starts before the television broadcast and is carried by it. The secretary of the community centre takes the initiative in organizing clubs and meetings but allows the people to make the decisions on activities. The program has led villagers to become active members in youth, women's and agricultural organizations.

5. In under-developed countries like Ghana and Mexico, radio and television are being used extensively to promote community development. Details of experiments in the mass media are given in various UNESCO Reports, notably "Mass Media in the Developing Countries" (1961) and "Developing Information Media in Africa" (1962).

6. In the interior of Australia the Australian Broadcasting Corporation has established extensive Schools of the Air programs by turning a network that was primarily for emergency purposes into a socially and educationally useful system. For this purpose, they have devised a transceiver that costs less than $150 a set.

PRESENT BROADCASTS FOR NATIVE PEOPLES IN CANADA

1. With these laudable objectives of the two publicly owned institutions let us look at what they and the private broadcasters are doing for native peoples.

Canadian Broadcasting Corporation

2. The only continuing program for Indians on the national networks of the CBC is INDIAN MAGAZINE, a weekly fifty-minute magazine-type presentation on the English radio network. Its producers describe it as "CBC's weekly forum for the opinions of Canada's Indians as well as news of Indian activities throughout the country".

3. A mimeographed summary of each week's program is mailed free to anyone requesting it. The mailing list is over 8,000. The host is Johnny Yesno, an Ojibway who was born at Fort Hope in northwestern Ontario.

4. In cooperation with the Indian-Eskimo Association, the Northern Service of the CBC is experimenting with a series of radio programs modelled on the Farm Radio Forum of the '40s and '50s. Their object is to produce an exchange of views among Indians and Eskimos themselves and also between experts and public officials and the public. The opinions of the native peoples are, where necessary, tape-recorded in their own language in their own communities. In Inuvik programs have been broadcast in English, Loucheux, and Eskimo; in Yellowknife in English, Dogrib, and Slavee.

5. The Northern Service broadcasts three programs a day, totalling nearly one and three quarter hours, in Eskimo by shortwave to the Arctic. The programs consist of news, information, opinions on matters of concern to Eskimos, legends, and other cultural expressions, and entertainment.

6. There are no programs for Indians or Eskimos on the French radio network of the CBC; nor on the French or English television networks.

Private Stations

7. None of the 230 private radio stations in Canada produces regular continuing programs for local Indian communities in English, French, or Indian languages. The only programs being produced by native people are the Alberta Native Communications Society (ANCS) programs in Cree and Blackfoot, carried on three Alberta stations (discussed more fully below) and INDIAN MAGAZINE, in whole or in part carried by stations affiliated to the English Radio Network of the CBC.

8. Nor are there any continuing programs for native peoples produced by private television stations or carried on the CTV Network.

Communities and Voluntary Groups

(a) The North

9. The tradition of small, locally operated community radio stations is well established in the North. Before the creation of the CBC Northern Service, they provided the only medium-wave broadcasts available in many remote and isolated communities All but one closed down when the CBC Northern Service medium-wave service became available. The exception was Fort Simpson, Northwest Territories, which started up in 1961 with the cooperation of the Department of Indian Affairs and Northern

Development and has continued sporadically since, even though the community is now served by an LPRT connected to the Mackenzie network of the Northern Service.

10. A similar station started at Pond Inlet in 1967 without official approval but was later legalized. It operates at low power on AM. Its programs are mainly for and by local Eskimos, with technical help from officers of the Ministry of Transport. It is a prototype of the station that other remote and isolated communities in the eastern Arctic would like to have.

(b) Alberta

11. In 1966 a weekly fifteen minute radio program in Cree, sponsored by the Department of Indian Affairs and Northern Development, was broadcast by CKUA Edmonton. This developed into a weekly half-hour program broadcast on CKUA, CFCW Camrose, and CKYL Peace River. The interest these broadcasts aroused led to the formation of the Alberta Native Communications Society (ANCS) whose aim is to develop and promote better communication among the native peoples of the Province. Its membership is restricted to Indians and Metis who formulate and implement their own policies. Its executive director is Eugene Steinhauer, a Cree.

12. The weekly Cree broadcasts reach 56,000 native people in central-northern Alberta, as well as Cree-speaking listeners in British Columbia and Saskatchewan. CKUA Edmonton carried the broadcasts free as a public service; CFCW Camrose and CKYL Peace River are paid to carry them by the Alberta Native Communications Society from funds provided by ARDA.

13. In March, 1969, the ANCS sponsored a fifteen minute weekly Blackfoot Radio Program under the direction of Ray Many Chief and Leslie Healey, broadcast by CJOC Lethbridge. It consists of topics in both English and Blackfoot.

14. In 1969 the ANCS was awarded a $210,000 grant, one-third from Alberta's Human Resources Development Authority and two-thirds from the Federal Government's ARDA program. The grant will allow it to expand its services and develop new programs of field work and research into the needs of native Canadians. Among other projects it will expand the Blackfoot Radio Program.

15. Alberta Native Communications Service is currently exploring the feasibility of developing a series of community radio stations throughout Alberta to ensure that all native communities are served.

(c) British Columbia

16. The Society for a Coastal Area Network (SCAN), a voluntary group of citizens, has been set up to improve communications among the Indian people of the B.C. Coast. It was originally financed by grants from Simon Fraser University, Le Centre des Recherches Sociales of Montreal and the Catholic Archdiocese of Victoria. Last fall the Donner Canadian Foundation gave it a grant of $60,000. It has developed plans for a Radio and Visual Educational Network (RAVEN) linking Indian communities in coastal B.C. It believes that what is needed is a massive public education drive cutting across tribal divisions and shortcircuiting the requirement-bound and time-wasting structure of the schools. It therefore proposes a radio network linking up every community along the coast, supplementing the visual media that will be put at the disposal of the Indian people, video-tape and film, and the know-how necessary to make them serve their education needs.

17. It plans to use the newly developed Single Sideband transmitters for the network. The SSB have a range of over 350 miles and could provide virtually uninterrupted contact among isolated Indian communities. Indian leaders who have taken over direction of the project have chosen six pilot backbone communities scattered along the entire length of the coast: Skidegate, New Aiyansh, Bella Bella, Alert Bay, which is being phased out of operation, could provide a central coordinating station for the network. Some such centre will be needed to coordinate the distribution of visual materials which would be sent out in response to radio requests.

(a) Northern Ontario

18. Last winter a group of young Ojibway people in northwestern Ontario started a project called KENOMADIWIN whose purpose is to use radio as a means of community development. It plans to use a small mobile broadcasting van travelling between Indian communities to gather and record programs which will be broadcast to other towns and reserves in northwestern Ontario; thus providing a news service for Indians in the area. With the support of the Northwestern Ontario Project of the Company of Young Canadians, a Thunder Bay Communications Group was established. It applied to the Department of Communications for a certificate to establish low power AM broadcasting antennae at eleven sites in northwestern Ontario. The application was rejected because certain technical details required were not given, and because only the CBC and the Department of National Defence have been authorized to operate broadcasting stations with a power lower than 100 watts.

CHAPTER VI

Terrestrial System Options for Northern Communications

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An investigation was made of the terrestrial systems options that are available to serve the North in Volume 5 of Telecommission Study 8(c). High Frequency (HF), Low Frequency (LF), radio relay, and tropospheric scatter systems were considered.

High Frequency Radio Systems

Except for earlier maritime operations, the 1930's saw the first HF radio communications established in the Canadian North. Since that time, particularly in the last twenty years, the communication systems reaching into the area have increased at a tremendous rate. From the earliest HF radio telegraph operations we have proceeded to the operation of troposcatter systems and in the near future to satellite systems.

In reviewing the past use of HF radio, the most noticeable point is the unplanned proliferation of many systems, of varying degrees of technical excellence, and the variety of both private and public systems. The justification of these systems ranged from the defence of our country to the guidance of a sportsman. HF communications have been used where no other radio communication system has been used, where no other radio communication system has been possible from either a technical or an economic viewpoint.

Where one or two communications channels are all that is required, over route distances of one hundred miles or greater, it has not been feasible to consider any alternate to HF radio. Certainly where the numbers of channels required reach the 50-60 range, other modes of operation such as troposcatter and line-of-sight radio relay would be considered. With the advent of satellite systems, the availability of multi-channel multi-point facilities will be increased.

If we consider that multi-channel systems will be required between some main locations, then we could assume the HF radio will provide the communications between these main and lesser locations and that many locations can be served. The important point here, is that even though there is a need for the multi-channel system, it will not reduce the future use of HF for the smaller localities.

How the increase in northern communications is carried out can bear heavily on how well we can employ HF communications regardless of the introduction of new multi-channel technology. This must be on the basis of using the best technique in each case based on economics, technology and the social needs of the area.

Equipment

The newer generation of solid state apparatus will provide reliability which is at least one order of magnitude better than the general run of equipment now in service. Maintenance of apparatus has and will always be a problem where skilled personnel are scarce and can not be readily transported. Fewer adjustments of this new equipment are required, and as a consequence few control knobs, etc. appear on new apparatus. This reduces illicit adjustment by untrained operating personnel.

The new equipment has a lower prime power requirement which permits its use in many locations where power may be a scarce item. In fact, emergency operation from batteries could be considered where the prime power source has failed.

For remote station operation, the radio equipment, switching and power equipment will require improvement in reliability. Power is the most difficult to improve. Traditional diesel generators are not the most reliable devices in the hands of inexperienced people. Consideration of fuel cells or other more sophisticated power sources could provide greater reliability. Back up emergency power should be considered where possible.

Main locations will usually employ higher power transmitters and on-site maintenance personnel would be available. For this reason the power supply is not as great a problem as it would be at remote low powered stations.

Wherever possible directional antennas should be used to increase circuit reliability and reduce interference. The use of non-directional antennas should be limited to low power stations.

Frequency Stability

The frequency stability of radio apparatus will require improvement if the trend is towards unattended operation. If Lincompex equipment is to be considered, the overall stability of HF radio systems will have to approach an error figure of one cycle in 10^7 (assuming a 12-15 MHz upper limit). This could be overcome by a synchronizing scheme employing the received signal as the reference. Perhaps common calling channels could be used to transmit a reference signal from a common source. If Lincompex is not used then an error of one cycle in 10^6 would suffice for unattended operation of SSB equipment. This assumes an acceptable level of demodulation with an error not greater than 10 cycles, for telephone communication and data transmission, up to 1200 bps.

Transmission Considerations

If we assume that in the end public communications in Canada will require interconnection, then to serve the total public sector serious consideration must be given to the problems of compatibility. Development of communications in Canada's North which require conversion of transmission or signalling features should be minimized.

An example is the very likely use of accoustical telephone couplers for the transmission of data. Although present couplers are normally used for low speed data (100 wpm) there is no serious technical reason for this limit. If Lincompex equipped HF trunks are part of the network and are switched in tandem the data user would obtain an inferior graded service when compared to normal telephone facilities, even though from a speech point of view the facilities would be accpetable. The noise levels may be excessive for greater percentages of time for even low speed data and for speeds in the order of 1200 bps the bandwidth and delay characteristics would limit the performance. It would seem likely that special techniques for data may be required to provide an acceptable performance level.

Today's manually switched or operated HF circuits allow for human monitoring of the circuit condition. The proposal for automatic unattended switching poses a real problem. Serious consideration must be given to the avoidance of unacceptable switching and supervisory failures on HF circuits. The using public will not understand why the failure has occurred - just that his service is not available or at least unsatisfactory.

Where possible, full-duplex trunks should be considered. Although the push-to-talk operation is understood and accepted by the remote user, on an interconnected call, the other user will be unfamiliar with the one-way operation. The resulting confusion is a frustrating experience.

Present day HF circuits are usually operated with an arbitrary net loss. The ability of future apparatus to operate with sufficient loss stability and to maintain echo and singing margins is not yet determined. The trunk loss should be kept as low as practical considering the design of the trunk, the echo tolerance of the user and the singing margin. Echo suppressors will be required if the round trip delay time exceeds about 45 milliseconds. Note the round trip delay of an HF trunk with Lincompex is at least 16 milliseconds. Two HF trunks in tandem plus a wire line facility at one end would likely be marginal and may require echo suppression or the increase of the design net loss of one or both trunks. As a comparison, the Lincompex equipment alone equals the delay in about 1,000 miles of microwave system.

With any system where delays of this order are possible, switching should be carried out on a 4 wire basis and strict attention to terminations at 2 wire points. Care must be exercised to maintain good impedance matching to avoid reflections and consequent echo.

HF Propagation Predictions

In the past very little operational use has been made of the scientific predictions of the maximum useable frequency (MUF) or the optimum working frequency. These predictions are available and with improved computer service the Department of Communications could render the user the guidance necessary to more efficient spectrum useage.

Accurate predictions could allow a more accurate determination of geographical separation of stations assigned to the same frequency. This, along with a proper appraisal of the users operating hours, would allow optimal sharing of the radio spectrum.

An additional benefit derived from accurate and frequent predictions would be the better choice of frequency for the varying nature of HF propagation. This would permit the assignment, on a short term basis, of frequencies which are close to the optimum working frequency for that period. Note that day and night frequencies will change diurnally, seasonally and over the sun spot cycle.

Regulatory Matters

New tools such as accurate propagation predictions and computer filed assignment information should make it possible to plan the improved use of the HF radio spectrum. Before these tools can be employed to their fullest extent the following refinements are suggested:

(1) Publication of guidelines and procedures for the HF bands, similar to those for the microwave bands.

(2) An investigation of the spectrum occupancy using new monitoring techniques. This will establish the necessary geographic separation of stations.

(3) The improved classification of users.

(4) The possibility of frequency assignments for shorter periods of time.

(5) Consideration of the licensing for specific hours of operation.

(6) Making available optimum working frequency maps to users of multifrequency systems.

(7) Re-evaluation of frequencies assigned large users on a traditional basis.

Radio Relay and Tropospheric Scatter Systems

The role that radio relay systems have, and will have, in the development of communications to the North and in the North is discussed below.

Requirements

1. Quality

The quality of a circuit is completely defined by two things:

- how much does it garble the message (fidelity)

- how often is it available (reliability).

Ultimately, there is no difference between the transmission requirements for the Northern part of Canada, and the Southern part. Psychologically the Vancouver business man will soon become intolerant of noisy and unreliable calls to Frobisher Bay; and the Eskimo will quickly recognize that the Prime Minister's face is not magenta. Technically, and possibly more important though, will be the enormous quantities of data that must go rapidly and accurately between the small "on site" computer of a northern mining operation and the main computer, snugly housed in its rarified, air-conditioned room at the company's headquarters. Psychologically or technically, Northern circuits carry information in the same form and at the same rate as Southern circuits and, ultimately, have the same quality requirements.

The word "ultimately" keeps cropping up because there is a catch to all of this. The better and more reliable a circuit is, the more it costs. Somebody has to pay.

2. Quantity

Here is where the big difference comes. The more circuits between any two places, the less each circuit costs. If

Pond Inlet, and every other small, northern community, had a real economic requirement for a thousand circuits, or even a few hundred, there would be no point in writing this report. Heavy route microwave and complex satellite systems would today bind together the North into one massive communications web, and north-south communications would be as reliable and inexpensive as southern ones.

Pond Inlet, however, does not have a real economic requirement for a thousand circuits. In fact, as a typical small isolated northern community it cannot economically justify even one circuit of a quality equal to those of the south. (Whether or not it should have one, good quality, circuit is not discussed in this section). At the moment, Pond Inlet has a single voice communication link that is operational about eighty percent of the time and requires frequent repetition of messages. This represents the low end of the communication spectrum, both in terms of quality and cost, and follows the philosophy that 'any communication is better than none at all'.

Thus development of northern communications involves the combining and balancing of two fundamentally contradictory requirements:

- good fidelity, reliable circuits, but

- relatively few to any geographical point.

Present Situation

Historically, and in order of importance, northern communications have developed using three main types of radio: (1) High Frequency (HF), (2) Tropospheric Scatter, and (3) Point-to-point radio systems.

(1) High Frequency radio was and is still almost always the first form of communication to a northern community. HF radio requires high power, is fairly unreliable, and carries a maximum of one or two poor quality circuits. On the other hand, HF radio can span thousands of miles in one jump and is inexpensive both to buy and maintain. Such systems have had, and will continue to have, an important role in northern communications

(2) Troposcatter Systems

Troposcatter radio systems provide reasonably good quality circuits with cross-sections to 120 voice

channels or more. They are much superior to HF circuits, but fall short of the standards normally associated with communications in the south. They are also much more expensive and are usually heavily supported by large government contracts. Nevertheless, when reasonable communication facilities were required in the North, troposcatter systems were, and in many cases still are, the only method of achieving them.

(3) Point-to-Point Systems

Point-to-point systems, up until now, provided the ultimate in good quality, long distance communications, and still carry the majority of east-west traffic. (Coaxial cable systems are just now becoming a reasonable supplement). However, such systems require a repeater about every 30 to 40 miles and, therefore, were prohibitively expensive to install and maintain in areas where there are no transportation facilities. For this reason, northern use of point-to-point radio has been almost entirely restricted to the north-west.

Future Trends

(1) HF Radio Systems

Satellite systems are similar to HF systems in that they can cover thousands of miles in one jump (to the satellite and back). It is expected too that they will be comparably priced. There the similarity ends, for it is expected that satellite systems will provide circuit quality equivalent to that available in the southern part of Canada. With a few exceptions, therefore, satellite communications will probably eclipse HF radio where the northern point of contact is geographically fixed.

(2) Troposcatter Systems

The same holds true for Troposcatter systems as they are presently used, ie very high power, brute force equipment. The 'scatter' mode of propogation, however, will likely still be used but in a more elegant and less expensive way.

(3) Satellite Systems

Satellite communication, as it is now envisaged, seems to be one very promising way of achieving good quality circuits without paying too high a price for them. Although, ultimately, the satellite will probably be used for as few as one or two channels to a community, it should initially

start as a group of channels (say 24) beamed to some central northern community, with ground facilities radiating from there to the smaller communities. A few years ago, these ground links would have been served by HF radio or conventional Troposcatter, despite the inherent problems of high power and low reliability. Even now, HF radio will often be the most practical way of providing this form of communication.

(4) Point-to-Point Systems

As mentioned earlier, conventional point-to-point systems require good transportation facilities. The newer, fully solid-state equipment has changed all that. Now it is possible to enclose ultra-reliable radio equipment, together with ultra-reliable, low-cost power equipment, in a single weather-proof container that can be transported bodily to just about any place in Canada. Strings of these repeaters can be used to join smaller centres to the satellite ground stations or, in some cases, avoid the need for a ground station and supply interconnection direct to the southern part of the country. This second application may be used for economic reasons, or as an alternative to using the limited spectrum available to a satellite. It is the purpose here to describe the factors involved in the design of light and medium capacity using such isolated repeaters.

Design Considerations

The key factor in developing this Isolated Repeater System approach is based upon a significant reduction in the installation and operating costs of the radio relay repeaters.

(1) Housings

Repeater housings must be inexpensive yet suitable to provide acceptable internal environmental control.

(2) Power

Where commercial power is not available, power sources, such as air depolarized batteries, thermal generators, thermoelectric converters, etc., are integrated into the basic housing design.

(3) Installation

In the majority of cases, equipment installation is completed at a central location in transportable repeater housings prior to the installation of the unit in the field. This greatly reduces the high engineering and installation charges often associated with radio repeaters.

(4) Maintenance

Reliability and stability of the complete isolated repeater allows operation for long periods of time without interruption of service and requires only one or, at the most, two scheduled maintenance visits per year. The exact timing of these visits is not critical.

(5) Site Selection

The design engineer has almost complete freedom in selecting his sites. In topographical areas characterized by low rolling hills or flat plains, repeater sites tend to be relatively closely spaced but use short towers and may be located close to the means of transportation, such as existing roads or winter roads, lakes or river chains, or any suitable point where site access is as economical as possible. In mountainous areas, through the use of helicopters, repeaters can be located in extremely high and remote locations. In this way, repeater spacing can be greatly increased with a subsequent decrease in overall system cost.

(6) Radio Frequency Bands and Propagation

Repeater spacing is directly dependent upon the propagation characteristics of the radio frequency band utilized. Since frequency congestion is generally not a problem in the North, it is practical to take advantage of the radio propagation characteristics of the lower frequency bands to either extend repeater spacing or minimize tower heights.

Conclusions

Radio Relay systems will be utilized in the development of the North, particularly to interconnect locations with a significant common interest, and also to extend systems connecting with the southern telecommunications networks. They will be used in combination with HF, Troposcatter and Satellite systems, depending on the relative cost and type of fidelity and reliability required.

Through careful engineering, light and medium route systems can be designed specifically adapted to the special Northern conditions at substantially reduced initial and operating costs, compared to systems that have been installed in the past.

Low Frequency (LF) Communication in the North

1. Introduction

Radio communications began at low frequencies, and if it were not for the limited bandwidth available, the intensity of atmospheric noise at these frequencies (particularly at low geographic latitudes), as well as certain practical limitations, further discussed below, much more extensive use would be made today of frequencies below about 300 kHz.

Because of the stability of propagation, frequencies in this range are useful not only for communications, but also for standard frequency and time broadcasts, as well as navigation systems employing pulse (Loran C at 100 kHz) or CW (Decca 70-130 kHz) or Omega (10-14 kHz), phase comparison or direction-finding techniques. In particular, it has been found that the stability of transmission permits frequency comparison to within a few parts in 10^{12} which is some four orders of magnitude better than is possible at high frequencies; thus making possible long range radio navigation utilizing phase comparison between spaced atomic frequency controlled or phase-locked transmissions. At frequencies above about 100 kHz, where it becomes practical to isolate, in some circumstances, the ground-and-sky waves by pulse and sampling techniques, highly accurate time systems can be devised. Marine communications use low and very low frequencies, which are also used for point-to-point communications at times of severe ionospheric disturbances (particularly at high latitudes) that disrupt high frequency circuits. Communication to points under the sea, beneath the ground, or below the polar ice cap can be achieved on these frequencies.

VLF frequencies (<30kHz) are normally employed for very long distance (world-wide) communications, and communication to submarines, and LF (frequencies <300 kHz down to a lower frequency limit of about 60 kHz) are most useful for transmission to distances <3000 km or so. The frequency range 30-60 kHz is useful for distances between these two extremes, but little current use is made of this frequency band.

The principal use of low frequencies (70-350 kHz) in Canada is for reliable communications in the Canadian North, particularly by the Department of Transport, for communication between shore-and-ship, for communication between ground-to-air airborne equipment (for routine weather information and back up to high frequency circuits), and for radio navigation (in

particular systems employing simple radio direction location methods for air navigation in the North). The many radio beacons in the Canadian North are, in an increasing number, being used as well for radio teletype transmissions over medium range links, which provide primary or back up service. A number of these circuits use error correction techniques, which improve tremendously the reliability of the transmission (noise at LF is impulsive in nature since individual lightning strokes propagate to the receiver with small frequency dispersion). Frequencies up to at least 350 kHz are not adversely affected at times of severe auroral or polar cap disturbances, in fact the signal strength is often enhanced at times of particularly intense daytime disturbances, disturbances that completely disrupt HF radio communication (black out). The atmospheric noise level is also very low in the Canadian North.

Frequencies below about 70 kHz are not used to any extent by Canadian communicators; there appear to be no Canadian based transmitters operating in the VLF frequency range.

A useful summary of low and very low frequency propagation has been given (Belrose, 1968); and some details concerning the engineering of communications systems for low and very low frequencies is given by Belrose, et al. (1950) and Watt (1967).

2. Some practical Considerations of LF Communications

Radio operators avoid using low radio frequencies if they can. The antenna systems employed are either of such large physical size that construction and maintenance costs are high; or they are so short with respect to the wavelength that radiation efficiencies are low, and the input impedance is very reactive (capacitive) with such low resistance that the band width of the antenna system is small, and the voltages on the antenna large for even moderate transmitter powers. A large tuning coil and a fairly extensive ground system must be employed. Changing weather condition results in some detuning of the antenna; in the extreme, freezing rain prevents operation entirely unless antenna sleet and ice melting circuitry is available. Automatic antenna tuning circuitry should be employed in a sophisticated system operating on more than one frequency; the returning of an LF antenna is a tedious time-consuming task. While such equipments are available they are not in use in Canada. Volume 5 of the Telecommission Study describes, as an example, the LF transmitting system employed at CRC for propagation Studies.

The receiving equipment should comprise a small electrostatically shielded loop antenna, 1 metre diameter, which should be located in an open field several hundred feet from the building housing the receiver and terminal equipment. The receiver should be transistorized, temperature stable, and should employ optimum bandwidth for the particular mode of operation. The receiver should employ impulse noise suppression before the bandwidth is narrowed. Mimumum shift FSK is the most efficient mode of operation at these frequencies, employing simplex or time-division multiplex, and error detection codes.

A closed loop error correction system should be employed, particularly for the southern end of a north-south link because of the higher levels at the more southerly location of atmospheric and man-made noise.

Detailed propagation considerations are beyond the scope of this brief report, but a few general comments follow. In general the longer the circuit the lower should be the operating frequency. The antennas should be so sited that sky wave is launched (and received) over sea water or ground of good conductivity, this is near grazing incidence. For example at 100 kHz over a 1500 km circuit that radiated (and received) field strength for a given transmitter power for the cases where the antenna foreground is sea water, rocky soil, arctic land and glacial ice would be reduced by factors of 0.86, 0.52, 0.3 and 0.09 over that for transmission (and reception) over a perfectly conducting flat earth. Since these factors apply at both the transmitter and receiver combined effect on the received field strength is the product of the antenna factors, i.e. in the above example a circuit where the antenna foreground is arctic land would require a transmitter power about 20 db greater than a circuit where the antenna foreground is sea water, for the same received field strength.

The poorly conducting terrain of the Canadian North also affects the phase of the wave, and hence the positional accuracy of a radio navigation system which depends on the phase of the received wave (Bourne, et al. 1968).

3. Present and Future Use of LF in Northern Canada

The use of LF communications in Canada has been briefly mentioned in the introduction of this report. These are

a) Radio beacons (200 - 350 kHz)
b) Communications (FSK, CW) over medium to long distances, either as primary or back up circuits.

c) Reception of time and frequency broadcast signals
d) Long Range navigation (Omega system 10 - 14 kHz)
e) Short to medium range navigation (and time) (Decca (70 - 130 kHz) and Loran C (100 kHz).

The many radio beacons in the Canadian North are in an increasing number being adapted as well for LF communications (i.e. combining (a) and (b) above). The present use of LF by the Ministry of Transport, the principal user of LF in Canada, is likely to continue, and to expand as the North is developed, even with the advent of communication satellites, and with the addition of new microwave links and land lines.

LF radio waves are not extensively used for navigation in the Canadian North, although the Ministry of Transport has some experience in the use of the Omega navigation system, but with the increasing need for reliable navigation systems (requirements for example to oversee Canadian sovereignty in Arctic waters and oil tankers using the Northwest Passage), there is an increasing need for navigation systems. The installation and maintenance of such systems as Loran C in the Canadian North would be very high. The most practical method for navigation in the Arctic would seem to utilize the Omega (10 - 14 kHz) radio navigation system of the US Navy. The accuracy of Omega navigation systems is not very high, being 1 - 3 miles under ideal propagation conditions; probably much worse in Arctic regions due in part to more frequent radio disturbances, and in part because of the poor conductivity of the land. An adaptation of the Omega system, not yet tried is Differential-Omega which would certainly work. In this method Omega monitor receivers would be located at all sites of the Ministry of Transport where HF and preferably LF communication is available, and updated corrections would be broadcast by radio to users of the system. The differential-Omega navigation method is being considered by the Ministry of Transport.

The development of transistors and integrated circuits has resulted in considerable improvement in the reliability of communication equipments, particularly in regard to receivers and associated terminal equipment. Solid state LF transmitters have been developed commercially, and Communications Research Centre, Department of Communications, have developed a solid state LF transceiver (500 watts) for reliable LF communications over short distances, distances of the order of 250 miles, employing an easily erected horizontal half-wave dipole antenna (about 2,000 feet tip-to-tip) laid on the surface of the ground (or preferably suspended a few feet off the ground) has been demonstrated, (Evans, 1970), which makes possible reliable communication from temporary or semi-permanent locations. The

requirement for a LG communication system could meet military and government needs where reliability is a principal requirement.

In conclusion LF radio communication has been and is being used for reliable communication in the North, and even with the advent of sophisticated satellite communication systems, with the installation of microwave links and land lines, LF radio is likely to continue to be used, either as a back up for these other systems, or a back up to HF radio at places where other reliable communication systems are not available.

CHAPTER VII

Communication Satellite Options

for

Northern Communications

CHAPTER VII

Communication Satellite Options for Northern Communications

A special project team was established to look into the feasibility of using communication satellites to realize substantial improvements in telecommunications service to the Canadian North. It consisted of representatives of the Trans Canada Telephone System, Telesat Canada, and the Department of Communications. The decision was made that two approaches would be taken to investigate the feasibility of communication satellite options for the North. The first approach would be to investigate what could be done using the first series of satellites planned for the Canadian Domestic System. This would provide communications at the earliest moment. The second approach would be to investigate what might be done in the future if a system were developed which was specially designed for this type of service, perhaps operating in a different frequency band.

At the present time in the Eastern Arctic, Nouveau Quebec and the Coast of Labrador, communities are dependent upon HF radio links provided by private users or by Bell Canada and by leased circuits on Military Tropospheric Scatter systems. The same general situation applies in the Western Arctic except that the leased circuits are provided in terrestrial facilities and open wire lines.

The mode of operation of the HF radio links (simplex operation) makes this type of service marginal at best, especially when the problems generated by limited hours of availability are coupled with poor transmission performance and heavy utilization. The access to existing military systems is limited and the capacity available for message traffic restricted.

An additional factor to be considered is the fluid nature of the population centres. It is expected that there will be a migration from outlying centres to larger centres like Frobisher Bay stimulated by government policy, economics and natural evolution. This would mean that small centres could disappear in the next ten years. Any expenditures for communication systems must take these factors into consideration.

A review of the communication requirements in the Canadian North related to the early plans for the Canadian Domestic Satellite System revealed that the initial application was for those population centres generating requirements for approximately twelve intertoll trunks. On the basis of one RF channel providing this type of service, up to seven of these stations might be used before the RF channel is fully loaded. The exact number of stations will depend on the quality of service required. Additional locations could be served if more RF channels were assigned to this service.

Partly as a result of the Telecommission Studies there is work now in progress by Telesat Canada for thin route service in the far North. This system is being designed for locations requiring 1 to 6 message (telephone or data) services. A characteristic of the thin route system is that the overall cost per circuit will be a minimum from 1 to 6 circuits per location as compared with the initial configuration with minimum system costs per location of 12 to 60 channels.

There are many small communities in the Canadian Arctic which at present have no service or very limited service using high frequency communications. These could conceivably be much better cared for if an arrangement could be found to provide them with one near commercial grade telephone channel on a 24 hour basis along the lines considered for the thin route system.

An analysis of the situation indicates that there is a large number of such locations. Some of these locations could conceivably have a requirement for two voice channels. The others would be adequately served by a single voice channel. Also there appears to be a requirement for a single teletype or telex channel at some of these locations.

In searching for a good technical solution to this problem it was natural to examine the use of communication satellites. Their ability to provide direct high quality communication channels to locations without consideration of the intervening terrestrial barriers make them a most attractive solution to this problem. The nature of the Canadian Arctic is such that it does not appear that it will ever be possible to provide an acceptable service to most of these locations using microwave, open-wire, or high frequency communications.

The first communication satellites had extremely limited effective radiated powers. Consequently their first application was in the international service where through international agreement the cost of channels is heavily inflated and through the construction of extremely large sensitive earth stations it appeared possible to produce a system which might be economically attractive. As technology advanced, the launchers became more powerful, the satellites could become larger, which in turn made it possible to increase their effective radiated power and the use of small earth

stations to provide a limited number of voice channels became more attractive. At the present time experiments are under way in this area in at least two countries (Australia and the United States). While it does not appear that these services could be economically viable because of technical limitations associated with sharing the operating frequencies with line-of-sight microwave systems the possibility of providing services in areas where this is the only potential technology could make the question of economics of lesser importance.

In order to estimate the cost of providing service into Northern Canada using the first series of satellites in the Canadian Domestic System, the working group developed a model on which the estimate would be based. Appendix 2 to this Chapter is the specification for the model.

The model on which the estimate is based provides only for service between the isolated areas and the earth station connecting the service into the existing national telecommunications network. This means that communications between two isolated areas may use a double hop in the communication satellite. The abnormal transmission delay experienced from this type of operation is considered to be objectionable by a large percentage of the telecommunications industry. However, some work has been done in evaluating the user objections to this type of service, and there is reason to believe that the users in isolated areas would accept this type of service. The contribution by Telesat Canada in Appendix I recognized this concern and has shown system characteristics and costs for both direct intra-northern communications and double hop communications via a southern earth station.

The use of a communications satellite to provide service to individual subscribers in isolated areas carries with it a number of problems which will require considerable effort before satisfactory solutions can be worked out. New and sometimes unique solutions will have to be obtained to the problems of operating, signalling, billing, numbering, switching, supervision, local distribution, interfacing between the common carriers and Telesat, if the medium is to be exploited.

For instance there is a problem of providing bilingual operators for this type of service. In order to provide bilingual service it is necessary to backhaul all of the circuits to the Montreal area. So the cost of integrating the service into the domestic network becomes a significant item in the total cost of the service. Furthermore the proposed technique of providing the service is not compatible with the present arrangement between Telesat and the common carriers for the interface between their facilities.

Another problem is related to the reluctance on the part of the telecommunication common carriers to provide facilities which cannot be easily expanded in the future. If through the provision of a new type of service there is an abnormal increase in the use of the facility, it must be expanded. It turns out that there are significant incremental increases in system costs when the amount of service being provided is increased and there is always a danger that the facility originally installed in the isolated area may rapidly become obsolete.

Another item which can be significant in the cost of implementing the service is the local distribution system in the area to be served.

The present arrangement for billing the customer is to charge in terms of who made what call and where to. A new and radical billing system may be needed before the facility is placed in operation.

Another problem which must be solved relates to the location of the master station providing the connection into the domestic system. It may be more appropriate to terminate circuits from the western sector of the Arctic at a station on the West Coast, depending on traffic flow patterns.

On the basis of the work which has been done it is easy to conclude that economics alone will not bring communications to Northern Canada.

In Table 1 of the contribution to Telesat Canada the cost of providing the service in the form of one dedicated voice channel per community is estimated to be $88,000 annually. The annual cost to the common carriers to link the service to the customer and provide the necessary toll centres has been estimated to be $600,000 for 50 sites. This breaks down to $12,000 per year per voice channel. The total annual cost, therefore, of providing one dedicated voice channel per community in lots of 50 communities is estimated to be $100,000 per year.

A contribution from the Communications Research Centre estimates the annual cost per community to provide one voice channel in a UHF satellite communication system, specifically tailored for this type of service, is estimated to be between $13,000 and $37,000 per circuit for systems of 100 terminals. This assumes a non-profit operation. For a larger number of terminals the cost per circuit decreases because of the lower cost of ground stations.

ANNEX 1 TO CHAPTER VII

Utilization of the ANIK Satellite

by

Telesat Canada

1. INTRODUCTION

This brief provides a survey of the various system concepts that may be applied to the provision of telecommunication services to the Canadian Far North utilizing the first generation of Telesat Canada satellites.

Planning for the initial domestic satellite system has been based on the provision of six satellite RF channels, allocated to potential users as follows:

1. - CBC, French Language Television.
2. - CBC, English Language Television.
3. - CBC, English Language Television.
4. - CN/CP and TCTS, Toronto-Vancouver Telephone Message Traffic.
5. - TCTS, Telephone Message Traffic to the North.
6. - Bell Canada, Experimental Use.

The satellite channel assigned to Northern telephone service is expected to initially provide circuits to Frobisher Bay and Resolute. This application will utilize about 30 of the 130 2-way circuit capacity of this RF channel in the FDM/FM frequency division multiple-access mode. The remaining capacity will be available for growth and if warranted the experimental RF channel could also provide further expansion of this service. In addition, alternative satellite designs are presently under evaluation which, if implemented, could provide additional flexibility and growth potential.

Television network service will be available to some 25 communities throughout the North initially by the provision of "Remote T.V. Receive-Only" earth stations. These stations will require a 25 foot diameter antenna ($G/T \approx 25.5$ dB) and will have the capability to accept additional equipment for telephone

message service if this is required. Since the satellite has full country-wide coverage, the television service may be extended to any location by the simple addition of an earth station where required.

Unlike the television service in which each television channel utilizes a full satellite RF channel, many telephone message circuits may be derived from one satellite RF channel in numerous ways, with each transmission method displaying its own cost and performance characteristics. The remainder of this brief is devoted to an examination of these methods for providing telephone message circuits to the North.

Early studies in the application of a Canadian satellite system for telephony to the North suggested it would find its primary use in serving communities requiring a minimum of 6 - 12 telephone trunks. The early studies also proposed that the most economic way of serving the smaller communities having even smaller requirements in the order of 1 or 2 circuits, would continue to be HF radio, either directly to the South or indirectly through the satellite earth stations located in the North. The Frobisher Bay and Resolute service mentioned earlier are a result of this planning.

Although early studies were correct in assuming that HF radio provided the lowest cost means of serving the smaller communities requiring only one circuit, it did not take into account the growing demand from these communities for a reliability and grade of service better than that available with HF radio. The Department of Communications has indicated strong interest in determining the extent to which economic support of this demand might be required, and as a result, Telesat Canada is currently undertaking an extensive evaluation of the technical means which could be used to provide one or two telephone or data channels to such locations in addition to providing trunk facilities to the large centres such as Frobisher Bay and Resolute. The objective is to select the most economic system which could be implemented within the first few years of operation of the Telesat satellite system. This brief provides an interim view of the work undertaken to date by Telesat Canada in this field.

2. THE PLANNING PHILOSOPHY

In the planning of improved telecommunications to the North, Telesat Canada has considered it important that the approach used be one that recognizes and takes into account the

long term implications of providing this service. For example, when a new service is provided by an operating agency, that agency assumes a responsibility to the populace concerned to continue the service and to reasonably meet growth demands over the years. To do so effectively, the source of revenue to meet these commitments must be established. Since telecommunication services to the North are unlikely to be commercially viable for some years, a realistic economic analysis and evaluation will provide an equitable basis for any assistance that may be agreed upon.

This approach underlines the need for decision making based on total annual charges taken over a planning period extending over seven to ten years. Total annual charges would include the major factors of return on investment, depreciation based on expected plant retirement from service, and operating and maintenance expenses as well as the other miscellaneous economic factors. These annual charge factors should be assessed based on provision of the total service, that is, Telesat's satellite link and the Common Carrier or telephone company's associated facilities and services. The long term view recommended here should also take into account the economic effects of early equipment retirements resulting from possible proposals to introduce new techniques.

The pertinent planning factors of traffic forecasts, service quality, cost and capacity of various system choices are discussed in the following paragraphs and appendices attached to this brief.

3. FORECAST OF TRAFFIC REQUIREMENTS

The preparation of a forecast of traffic requirements in the North is a pre-requisite to the choice by Telesat Canada of a suitable communication satellite system configuration to meet them. It is recognized that the forecast of requirements for the North is a difficult process and is affected by many factors including the cost of the service. Telesat Canada is sufficiently advanced in the study of alternative systems to be able to discuss the relationship between the costs, circuit quantities, traffic routing and growth capability. Furthermore, traffic forecasts should be established in consultations between the Department of Communications, the Common Carriers and Telesat Canada and planning or action should be implemented on the basis of such forecasts in consultation with all parties concerned.

Some of the major factors affecting the system design include the potential growth of telephone traffic over the initial 5 and 10 year period and the likelihood of the need of television in the future to these small communities. In the Appendix, systems are shown with capacities of from 15 to 400 two-way voice circuits per satellite channel according to the modulation scheme and type of earth station utilized.

Clearly, the numbers of circuits per location, numbers of locations, the need for inter-Arctic communications and forecasted growth should be carefully assessed if wasteful or inadequate designs are to be avoided.

4. QUALITY OF SERVICE

The systems for the North described in the Appendix are capable of a wide range of performance, ranging from that usual in Southern Canada to lower grade systems. The choice of the noise performance of a telephone circuit affects the satellite channel capacity and therefore has a direct bearing on the cost to customers. Results are shown in the Appendix of the variation of capacity with noise performance. This is intended to assist potential customers in making a choice between grade of service and costs. For example, one system (FDM/DM/FDMA) using 15 ft. diameter antennas and an uncooled receiver can provide 12 voice circuits to each of 10 locations with a noise performance of 38 dBrnc0 or to each of 20 locations with a noise performance of 44 dBrnc0. The noise of 38 dBrnc0 is typical of 2000 mile link in southern Canada whereas a lower performance of 44 dBrnc0 is typical of present tropospheric scatter systems to the North. A similar change in noise performance for a one voice channel per location system (FM/FDMA, voice activated) using the same earth station design would increase the number of remote communities served from 40 to 65.

Service availability, that is the percentage of the time the facility is working satisfactorily, is another quality factor directly affecting the cost of service to remote Northern locations. Service availability is directly dependent on the maintenance effort expended at earth stations, the logistics of spare parts, and the built-in equipment redundancy. All these factors affect the operating cost. For example, one of the stations whose costs are provided in the Appendix, has an estimated availability of 98.2% or an estimated outage of 160 hours per year for unattended operation. The cost to reduce this outage to 3 hours per year would require an increase of 30 - 40% of the station first cost by providing equipment

redundancy. Alternatively, a similar improvement may be achieved through having selected on site spares and having available a trained technician on site. Therefore, considerable care must be exercised in developing a scheme to ensure that both the quality of service is acceptable to the users and the costs are reasonable.

5. INTEGRATION WITH THE TELEPHONE NETWORK

Planning of a communication satellite system to serve the Far North requires that proper consideration be given to the technical integration with existing communication facilities. In addition, the cost of a service to the end user must take account of the cost of both the satellite and terrestrial services. To this end Telesat Canada is in regular consultation with the Common Carriers with the objective of providing a good and cost effective overall system design.

6. ALTERNATIVE SYSTEM PLANS

Telesat Canada has examined some five alternative modulation and multiple-access systems for serving the Canadian North. Three of the most attractive systems are reported on in the Appendix* including FDM/FM/FDMA, FM/FDMA and PCM/PSK/FDMA systems. This includes several variants of these basic systems, including pre-assigned, and demand-assigned systems. All of these systems are compatible with the initial satellite design.

The systems described in the Appendix were studied in detail with respect to their suitability for meeting the telecommunications needs of the North. These studies have included the relative cost advantages of the systems in meeting different assumed traffic requirements and growth rates, traffic routing flexibility, system operation and maintenance. Other systems which are being examined are a Delta modulation scheme and a PCM/PSK/TDMA system. However, these are not considered to be strong contenders for an initial system.

7. ANNUAL COSTS

Preliminary annual charge studies have been undertaken to determine the order of magnitude of the annual costs for the satellite system portion of various alternatives. The space segment portion of the satellite system costs may vary widely over approximately $1 million to $3 million per year per RF channel depending on the satellite design chosen, the procurement policies followed and the commercial agreements negotiated, all of which, at this time of writing, are under review. The per channel cost of an expansion of the initial satellite system could be substantially lower than those for the initial system.

* Telecommission Study 8(c) - Volume 6.

TABLE I

TYPICAL SYSTEM ANNUAL COSTS

	System A(1) x $1,000	System B(2) x $1,000	System C(3) x $1,000
Number of communities served	26	26	65
Number of circuits/community	1	shared(4)	4
Total circuits through one RF channel	26	26	260
First Costs (earth segment)	$ 2,100	$ 2,600	$26,000
Annual cost (earth segment) (5)	$ 700	$ 900	$ 8,700
Total annual cost (assuming $3 m/year/satellite RF channel)	$ 3,700	$ 1,900	$11,700
Total annual cost/community	$ 142	$ 73	$ 180
Total cost/circuit	$ 142	-	$ 45

NOTES:

(1) System A is a voice activated, single voice channel per carrier FM system with 10 ft. diameter earth station antennas and G/T = 16 dB.

(2) System B is similar to A except that improved circuit utilization is achieved through the use of a simple demand assigned system.

(3) System C is a modified Spade System with 30 ft. diameter antennas and G/T = 26 dB.

TABLE I (Contd.)

(4) Eight circuits through the satellite channel are shared between all stations.

(5) The factors that have been assumed in computing annual costs are for illustration purposes only. For example, depreciation rate is based on an assumed life of 10 years for earth stations and capital expenditures all occur at the same time. Maintenance expense is assumed to be 10% of first costs rather than a figure arrived at by assessing maintenance problems in the far North, etc. The study will be refined in future weeks as the necessary data is developed.

To illustrate the relationships between annual cost, service provided and system design examples typical of a small size station design are shown in Table 1.

The examples quoted here demonstrate the normally expected lower cost per circuit when a larger antenna (higher G/T value) is used. However, to realize fully this economic advantage, the circuit capability associated with the large antenna must approximate the traffic requirements forecast.

It should be realized that the larger system "C" may also be instituted utilizing only a portion of a satellite RF channel and serving a corresponding fewer communities and requiring a lower initial capital expenditure.

It is also of interest to note that the larger antenna, used in the example, is about the smallest size suitable for T.V. reception. This offers the possibility for reduction in charges by sharing of certain costs between the telephone and T.V. services. The Appendix provides preliminary data and costs on a wide range of other system designs.

8. TIMING OF INITIAL SERVICE

Telesat Canada can provide service to remote locations in the North during the first year of operation of the domestic satellite system. This timing is dependent on potential customers identifying their forecasted requirements by the end of 1970.

9. SUMMARY

(i) All agencies concerned have agreed upon plans for the provision of network television distribution and telephone trunk requirements (minimum 6-12 circuits) to the far North utilizing Telesat's initial satellite.

(ii) A plan to utilize the satellite system for improving telecommunications to very small communities in the far North has not yet been agreed upon.

(iii) This brief provides preliminary information on the satellite link planning factors necessary to the formulation of an acceptable plan.

(iv) Annual charge information provided here is for illustration purposes only since determination of

space segment charges must await a decision on satellite procurement policy and total charges must await formation of a commercial policy.

(v) The initial satellite system is capable of providing in a variety of ways a significant and expanding "small community" telecommunication service to the North.

(vi) Formulation and implementation of a sound plan can best be achieved through realistic and practical long range economic comparison studies of the various alternatives.

(vii) Telesat Canada recognizes the special importance of satellite communication techniques in the North and is prepared to cooperate fully with all agencies in the formulation and implementation of a suitable plan.

ADDENDUM TO ANNEX I

UPDATED INFORMATION

Utilization of the ANIK Satellite

by

Telesat Canada

TABLE I

TYPICAL SYSTEM ANNUAL COSTS

- ONE DEDICATED VOICE CHANNEL PER COMMUNITY
- CALLS ROUTED BY AN OPERATOR IN SOUTHERN CANADA

Number of communities	50	100	200	400
First Costs Earth Segment average $120 K/Northern Station (1)	$ 6.0 m	$12.0 m	$24.00 m	$48.0 m
Annual Cost Earth Segment (2)	$ 2.0 m	$ 4.0 m	$ 8.0 m	$16.0 m
Satellite RF Channels required	1.2	2.4	4.8	9.7
Space Segment Annual Cost (4) (assuming $2 M/year/Satellite RF Channel)	$ 2.4 m	$ 4.8 m	$ 9.6 m	$19.4 m
Total Annual Cost	$ 4.4 m	$ 8.8 m	$17.6 m	$35.4 m
Total Annual Cost/Community	$88 k	$88 k	$88 k	$88 k

(1) Stations will cost in the range of $90 - 150K, depending on the location involved. Some of the factors causing this variation are items such as installation, shipping costs, Provincial Sales Tax and civil engineering works. The total cost also includes allowance for the cost expended at the southern earth station.

(2) The factors that have been assumed in computing annual costs are for illustration purposes only. For example, the depreciation is assumed to be linear over a 10 year life with no salvage. Capital expenditures are assumed all to occur at the same time. Maintenance is assumed to be 10% of the first cost rather than a figure arrived at through assessing maintenance requirements in detail.

TABLE I (Cont.)

(3) All calls between Northern locations are routed via the Allan Park earth station to enable them to be handled by operators in Southern Canada. This requires two satellite hops for calls between the North and therefore introduces round trip delays of 1200 milliseconds. The quality of such calls with this delay are likely to be unacceptable to users unless 4 wire telephone sets are used in the Northern communities. The use of 4 wire telephone sets would incur an additional cost.

(4) The space segment portion of the satellite system may vary over approximately \$1 - \$3 million per year per RF channel depending on the procurement policies followed and commercial agreements negotiated.

(5) The costs quoted exclude those which would be incurred by the Common Carriers.

TABLE II

TYPICAL SYSTEM ANNUAL COSTS

- ONE DEDICATED VOICE CHANNEL PER COMMUNITY
- CALLS AUTOMATICALLY SWITCHED BETWEEN NORTHERN COMMUNITIES (3)

Number of Communities	50	100	200	400
First Costs Earth Segment Average $155 K/Station (1)	$ 8.2 m	$ 15.5 m	$ 31.0 m	$ 62.0 m
Annual Cost Earth Segment (2)	$ 2.7 m	$ 5.2 m	$ 10.3 m	$ 20.7 m
Satellite RF Channels required	0.7 m	1.4	2.8	5.6
Space Segment Annual Cost (5) (assuming $2.0 M/year/Satellite RF channel)	$ 1.4 m	$ 2.8 m	$ 5.6 m	$ 11.2 m
TOTAL annual cost	$ 4.1 m	$ 8.0 m	$ 15.9 m	$ 31.9 m
TOTAL annual cost/community	$80. k	$ 80 k	$ 80 k	$ 80 k

(1) Stations will cost in the range of $130 - 180 k, depending on the location involved. Some of the factors causing this variation are items such as installation, shipping costs, Provincial Sales Tax, and civil engineering works. The total cost also includes an allowance for the cost expended at the southern earth station.

(2) The factors that have been assumed in computing annual costs are for illustration purposes only. For example, the depreciation is assumed to be linear over a 10-year life with no salvage. Capital expenditures are assumed all to occur at the same time. Maintenance is assumed to be 10% of the first cost rather than a figure arrived at through assessing maintenance requirements in detail.

TABLE II (Cont.)

(3) The costs include the provision for forwarding information to Southern Canada concerning calls originated, duration of calls, etc., but not the recording and processing of such information.

(4) Calls between Northern locations require one satellite hop. The feasibility of achieving this is dependent on suitable coordination between users of the orbit of interest to Canada in order to reduce adjacent system interference.

(5) The space segment portion of the satellite system may vary over approximately \$1 - \$3 million per year per RF channel depending on the procurement policies followed and commercial agreements negotiated.

(6) The costs quoted here exclude those which would be incurred by the Common Carriers.

(7) The system considered here uses some demand assigned features. It is to be recognized therefore that although communities are shown to have the capability of receiving one dedicated voice channel per location there would in fact be an improvement in the use of RF channels which is not reflected in the space segment costs here.

TABLE III

TYPICAL SYSTEM ANNUAL COSTS

- 20 COMMUNITIES WITH ONE DEDICATED VOICE AND TELETYPE CIRCUIT EACH
- REMAINING COMMUNITIES SHARING VOICE CIRCUITS IN THE PROPORTION 1:4
- CALLS ROUTED BY AN OPERATOR IN SOUTHERN CANADA

Number of Communities	50	100	200	400
First costs Earth Segment Average $120K/station (1).	$ 6.0 m	$ 12.0 m	$24.0 m	$ 48.0 m
Annual Cost Earth Segment	$ 2.0 m	$ 4.0 m	$ 8.0 m	$ 16.0 m
Satellite RF Channels Required	0.7	1.0	1.6	2.8
Space Segment Annual Cost (assuming $2.0 m/year/satellite RF channel)	$ 1.4 m	$ 2.0 m	$ 3.2 m	$ 5.6 m
TOTAL annual cost	$ 3.4 m	$ 6.0 m	$11.2 m	$ 21.6 m
TOTAL annual cost/community	$68. k	$ 60 k	$56 k	$ 54 k

(1) Stations will cost in the range of $130 - 180K depending on the location involved. Some of the factors causing this variation are items such as installation, shipping costs, Provincial Sales Tax, and civil engineering works. The total cost also includes an allowance for the cost expended at the Southern earth station.

(2) The factors that have been assumed in computing annual costs are for illustration purposes only. For example, the depreciation is assumed to be linear over a 10 year life with no salvage. Capital expenditures are assumed all to occur at the same time. Maintenance is assumed to be 10% of the first cost rather than a figure arrived at through assessing maintenance requirements in detail.

TABLE III (Cont.)

(3) All calls between Northern locations are routed via the Allan Park earth station to enable them to be handled by operators in Southern Canada. This requires two satellite hops and therefore introduces round trip delays of 1200 milliseconds. The quality of such calls with this delay are likely to be unacceptable to users unless 4 wire telephone sets are used in Northern communities. The use of 4 wire telephone sets would incur an additional cost.

(4) The space segment portion of the satellite system may vary over approximately \$1 - \$3 million per RF channel depending on the procurement policies followed and commercial agreements negotiated.

(5) The costs quoted exclude those which would be incurred by the Common Carriers.

TABLE IV

- 20 COMMUNITIES WITH ONE DEDICATED VOICE AND TELETYPE CIRCUIT EACH
- REMAINING COMMUNITIES SHARING VOICE CIRCUITS IN THE PROPORTION 1:4
- CALLS AUTOMATICALLY SWITCHED BETWEEN NORTHERN COMMUNITIES (3)

Number of communities	50	100	200	400
First costs of earth segment (Average $155k/station (1)	$ 8.2 m	$ 15.5 m	$ 31.0 m	62.0 m
Annual cost earth segment (2)	$ 2.7 m	$ 5.2 m	$ 10.3 m	$ 20.7 m
Satellite RF channels required	0.4	0.6	0.9	1.6
Space segment annual cost (assuming $2.0 m/year/satellite RF channel)	$ 0.8 m	$ 1.2 m	$ 1.8 m	$ 3.2 m
TOTAL annual cost	$ 3.5 m	$ 6.4 m	$ 12.1 m	$ 23.9 m
TOTAL annual cost/community	$70 k	$ 64 k	$ 60 k	$ 60 k

(1) Stations will cost in the range of $130 - 180k depending on the location involved. Some of the factors causing this variation are items such as installation, shipping costs, Provincial Sales Tax, and civil engineering works. The total cost also includes an allowance for the cost expended at the southern earth station.

(2) The factors that have been assumed in computing annual costs are for illustration purposes only. For example, the depreciation is assumed to be linear over a 10-year life with no salvage. Capital expenditures are assumed all to occur at the same time. Maintenance is assumed to be 10% of the first cost rather than a figure arrived at through assessing maintenance requirements in detail.

TABLE IV (Cont.)

(3) The costs include the provision for forwarding information to Southern Canada concerning calls originated, duration of calls, etc., but not the processing of such information.

(4) Calls between Northern locations require one satellite hop. The feasibility of achieving this is dependent on suitable coordination between users of the orbit of interest to Canada in order to avoid adjacent system interference.

(5) The space segment portion of the satellite system may vary over approximately \$1 - 3 million per RF channel depending on the procurement policies followed and commercial agreements negotiated.

(6) The costs quoted here exclude those which would be incurred by the Common Carrier.

(7) The system considered here uses some demand assigned features. It is to be recognized therefore that although communities are shown to have the capability of receiving one dedicated voice channel per location there would be in fact an improvement in the use of RF channels which is not reflected in the space segment costs here.

ANNEX 2 TO CHAPTER VII

SYSTEM MODEL

Satellite Communications into Northern Canada

At a meeting held with representatives of TCTS and Telesat it was agreed that the estimates for the cost of a system would be based on the following model.

Number of subscribers - 50, 100, 200, 400

One estimate will be prepared on the basis that there is one dedicated channel to each subscriber.

Another estimate would be based on the assumption that there would in each case be 20 subscribers each with a dedicated channel. The remaining subscribers would share a pool of channels in the ratio of four subscribers per channel.

In other words - the total number of channels in the system would be $20 + (\frac{N - 20}{4})$ where N = the number of subscribers.

All channels would operate between the northern stations and the domestic network - channels between northern points would use double hops over the satellite.

75% of the traffic would be within any particular region.

25% of the traffic would be between any subscriber within a region and the domestic network.

Performance between the domestic system and the North would be 44 dBrnCo.

Performance from the North into the domestic network would be 37.5 dBrnCo.

Each remote earth station would have two transmitters and receivers.

The maximum acceptable outage is two to three days twice per year.

The 20 dedicated channels would each carry one full-time teletype channel.

The system would be managed by an operator where it connects into the domestic system.

CHAPTER VIII

Northern Coordination and Planning

CHAPTER VIII

Northern Coordination and Planning

> "The challenge therefore is to develop a national consensus not only on goals but on the institutional innovations required to meet the emerging objectives."

In this study of communications in "the North" there have been estimates of the economic prospects and the social needs of residents. Suggestions have been offered regarding the ways in which communications can be developed to foster the growth of the economy and stabilize the settlement of people.

Two facts emerge at this point: for communication the north cannot be defined as territory lying above the 60 degree parallel; and the scale of funding to bring the level of services to southern standards may require a cooperative approach on the part of many authorities and agencies active in the north.

There are many telecommunication common carriers serving the north. CN Telecommunication operate in the Yukon, the MacKenzie and Great Slave area of the N.W.T., and Northern British Columbia: Bell Canada provide service to the Central and Eastern Arctic, and northern Ontario, Quebec, and Newfoundland (Labrador); British Columbia Telephone Company, Alberta Government Telephone Company, Saskatchewan Telephones, and the Manitoba Telephone System operate in the western Provinces. Ontario Northland Transportation Commission and Quebec Telephone serve northern Ontario and Quebec.

A study by the Province of Manitoba Royal Commission enquiry into Northern Transportation (the MAURO Report) commented at page 192 on transportation and communication facilities in northern Manitoba. Its findings could be applied with validity to the situation in northern Saskatchewan, Ontario, Quebec, and the Northwest Territories . . .

> "Communications is itself a form of transportation although limited to the movement of intangibles. The availability of adequate communication facilities is as necessary as transport if acceptable standards are to be achieved. In many cases telegraph and postal service throughout the study area

do not meet minimum modern requirements. We define such minimum standards as the availability of voice communication on an uninterrupted basis, at reasonable cost. We do not suggest that every resident in the province or in a given area of the province be offered telephone service, but it is our view that in every community of over fifty persons there should be available facilities for voice communication not subject to vagaries of weather or atmosphere conditions."

". . . The state has an obligation to provide transportation and communication at minimum standards regardless of cost-benefit considerations. Provision of transportation above minimum standard must be considered in terms of contribution to the economic development of the region."

In some places, as in the outports of Labrador, there is official encouragement to leave settlements and concentrate in urban centres. From the point of view of a commercial carrier, the development and maintenance of communications in such diminishing areas is not justified without government encouragement. Even the most socially-oriented boardroom would find it difficult to vote the large sums necessary to give these places the amenity features of southern communications. The provision of reliable all-weather links, however, should not be beyond the range of a carrier if enough time is allowed. An accelerated demand, prompted by resource developments or because of social and political pressures, would strain the resources of the carrier.

A Trans-Canada Telephone System brief makes the following points:

"The telecommunications carriers regard it as essential to the success of any development that the government accept a leadership role in defining the needs and objectives, and take immediate steps to establish the necessary policies. The carriers are ready and willing, now as in the past, to cooperate with the government by providing and operating those telecommunications facilities. There is no doubt that financial participation by the government is required to ensure the rapid implementation of the development program."

It seems that there is a legitimate role for the federal government as co-ordinator and catalyst for action and this was foreseen by Parliament when it established the Department of Communications.

Section 4 of the Act provides:

"The duties, powers and functions of the Minister of Communications extend to and include all matters over which the Parliament of Canada has jurisdiction, not by law assigned to any other department, branch or agency of the Government of Canada, relating to:

(a) telecommunications; and

(b) the development and utilization generally of communication undertakings, facilities, systems and services for Canada.

Section 5 provides:

The Minister of Communications, in exercising his powers and carrying out his duties and functions under section 4, shall:

(a) coordinate, promote and recommend national policies and programs with respect to communication services for Canada, including the Canada Post Office;

(b) promote the establishment, development and efficiency of communication systems and facilities for Canada;

(c) assist Canadian communication systems and facilities to adjust to changing domestic and international conditions;

(d) plan and coordinate telecommunication services for departments, branches and agences of the Government of Canada;

(e) compile and keep up to date detailed information in respect of communication systems and facilities and of trends and developments in Canada and abroad relating to communication matters; and

(f) take such action as may be necessary to secure, by international regulation or otherwise, the rights of Canada in communication matters.

The inadequacy of communication service in many communities in the northern parts of the provinces suggests that a joint federal-provincial approach is essential. The case for the participatory form is based on the recommendations of the MAURO Report (Province of Manitoba Royal Commission Inquiry into Northern Transportation), the Carrothers Report, the Political Economy of the Canadian North by Professor K.J. Rea.

The subject of federal-provincial consultations must be a matter of deep concern to all Canadians and it is interesting to note that in a report on the Intergovernmental Machinery by Queen's University an Appendix showed the many different interfaces where contact exists. The list may not represent an up-to-date statement of the position in 1971 but is believed to be a good starting point for a general enquiry. One notable lacuna is the virtually complete absence of machinery for development of communications and although the report was primarily concerned with economic liaison it must be conceded that the communications field had not developed a specific mechanism for consultation.

One approach that has been suggested would be to devise a plenary consultative committee body consisting of appointees representing all governmental authorities and carriers with a northern interest and with members reflecting consumer views and offering a participatory function for ethnic groups. They would be charged with preparing two five year plans for a coordinated northern program. The financing of regionally desirable schemes would be agreed upon on a contributory basis related to the population being served and the estimated benefits. No rigid pre-formulation would be written in. If a provincial authority wished to embark on schemes outside the main plans it would do so at its own cost but it would be expected not to lessen its input to the main effort. The ownership of the facilities thus created would be vested in the political authority for the geographical area concerned. Ownership would cease at boundaries. A commercial carrier, wishing to retain control of equipment could build or buy in areas where there is no provincial government agency. Thus Bell could develop in the eastern North but could not expand in, say Alberta.

One obvious difficulty is the size of the organization of the governing body, and the point has been well made by Professor Rea who traced some of the practical difficulties of coordination. He found it difficult to imagine so broadly based an agency having much more than an advisory function. He felt it could have little to do with the actual undertaking of particular projects and the administration

of a program of development in any detail. He noted, however, that the advantage of such a broadly based agency would be that it would not only create a more natural area for planning but ideally it would make possible a much more economical allocation of national resources to the purpose of northern development.

At a later point he wrote:

> ". . . when modern techniques of communication are taken into account, it would appear to be both economically desirable and physically feasible to plan future development of all the Arctic and sub-Arctic regions as a whole."

He suggested that an agency be so organized as to give representation to all the important specialized agencies, private and public, involved in the economic life of the area. And at page 378 he added:

> ". . . because the fundamental purpose of establishing a regional development agency would be to realize the economies to be gained from coordinating all such activities, the structure of the agency would necessarily have to incorporate those involved in its activities.

Perhaps at this point reference can be made to a report submitted on the Third Northern Research Conference held May the 27th to 29th, 1970, at Poste-de-la-baleine which brought together directors of most of the research institutes in Canadian universities.

> "The tone of the conference was that the research in the North was reaching a juncture point. Few of the institutes are considered major activities by their universities and in the last seven years much of their financing has been funded by a grant programme sponsored by IAND.
>
> . . . There is a sense of frustration among a good number of academics who pointed out that at a time when Canadian interest in the North has reached a new peak; when there was an awareness that a number of basic questions about the North remained to be answered; and that a growing shortage of trained scientists to work in the Canadian Arctic is making itself apparent, research programmes were being cut back.

> . . . In reviewing the programmes of the various institutes, it is evident that much of the research work that has been going on in the North in the past years has been concentrated on a very narrow range of physical sciences; for the most part geophysical and other earth sciences, zoological and entomological. Research groups tend to be small, very poorly integrated and in most universities the institutes are really only shelters for small groups for particular professors who have a specialized interest in their subject as it relates to the North. There has been very little done in the way of coordination of programmes and almost nothing with respect to multi-disciplinary or inter-disciplinary research work. Even less attention has been paid to the social sciences."

A great deal can be done to weld these various research and academic units into an effective, co-ordinated programme working on a financial basis which would not be susceptible to change. A cohesive programme would do away with narrowly oriented, poorly integrated task forces.

What other approaches can be suggested? What measures can be employed? How far, for instance, can a rate increase or a reduction be used to stimulate or retard communication development? When used to carry out provincial and federal policy special rate structures for the north might have merit. How much can a carrier direct from distributable revenue to develop commercially unprofitable networks?

If rates are not a complete policy, then how about taxes? Can special tax write-offs and other preferential devices be used to encourage carriers to develop in named areas? Would the governments concerned forego sales taxes or excise levies in order to encourage specific projects? So far the federal government has resisted any suggestion of preferential tax schedules to compensate the northern resident for the cost of living.

While the example of rates, subsidies and tax preferences might not be too persuasive, they are not the only devices to be examined. An alternative might be a form of investment insurance scheme designed

to encourage carrier investment. If, for instance, a carrier was reluctant to commit itself to a major investment in a high risk undertaking such as a service to an isolated mining community, some guarantee formula might be offered. Thus, if the mine development was closed out prematurely, the carrier would be protected against loss of unamortized capital. Yet another approach could be for oil and gas companies to obtain obsolescence allowances for their communications equipment on the same basis as their depletion allowances for mining equipment.

Another approach which may appeal is the Trans-Canada Highway method. It has a record of success and a whole generation of administrative know-how has been accumulated. Subject to including the Territories in the definition of "Provinces" and changing the Ministerial reference, the form of the Trans-Canada Highway Act offers a strong flexible base for a 'Skyway to the North'. Section 3 could be easily adapted:

> "3. (1) With the approval of the Governor in Council the Minister may enter into an agreement with any province providing for the payment by Canada to the province of contributions in respect of the cost within the province as part of a Trans-Canada Highway.
>
> (2) An agreement made under subsection (1) shall prescribe the location, standards and the time and method of the construction of the highway and shall include terms and conditions for
>
> (a) the calling of tenders and the review by the Minister of tenders and specifications,
>
> (b) the inspection by the Minister of the highway during construction,
>
> (c) the method of determining the cost of construction,
>
> (d) the examination, inspection and audit of all construction costs and accounts, and
>
> (e) such other terms and conditions as the Minister may consider necessary or desirable."

It has been argued by some that the role of the Department of Communications would have to be modified to make it a funding or operational department and that the legislation would have to be changed if it engaged in functions similar to construction and operation of airports by the Ministry of Transport.

But perhaps before the apostles of change dismember the existing structures and substitute some bright new mechanism we should note that Canada has achieved more in meeting its legitimate communication needs than many better endowed countries serving greater populations in countries with less formidable geography. The countries with state owned facilities do not approach the Canadian standards, the countries with ownership of communication in private hands do not offer better service. It is unarguable that there is room for improvement, but nowhere has the state of things in Canada suggested we must move from evolution to revolution. The case for more provincial control over tariffs having a direct impact on provincial residents and businesses is being pressed with vigour by the provinces; but recognition must be given to the virtual impossibility of reconciling local demands for tariff relief with the national need for sustained improvement. Experience suggests the presence of a federal balance wheel is needed to damp out possible provincial disharmonies. Perhaps what we are viewing is a peak or crisis of short duration heightened by a phase of intense technological change and heavy investment. The arrival of satellites, computers, lasers, improved switching, microwave systems, multi-channel cables, cable networks means a frantic scramble for operating capital either from investors or taxpayers. It is imperative that unless chaos is to follow there must be an agreed programme of priorities to marshall the competing demands for manpower, money and materials. As a first step each authority having a northern communications interest should consider developing a small group with a specifically northern commitment. One would expect to find attached to the group men and women who have experience in the North and who are qualified in engineering, economics or sociology. Supporting them would be the normal general administrative pattern from which the group is recruited. These groups would be the idea-people and the feasibility-people. They would develop recommendations on priorities. This form of small group planning would be pragmatic and lower key. Each problem would be taken in its turn instead of being slotted into a fixed schedule. Outwardly the scheme of things would not change, but internally each concerned authority would be identifying northern needs and giving them an individual focus.

Whatever suggestions the federal government heeds to there seems

to be no reason why Canada and the provinces cannot continue to draw upon the investment of administrative experience and goodwill that the Trans-Canada Highway Act provided. The suggestions are not definitive and anyone who examines the schedules of corporations in the Financial Administration Act will realize that Canadian ingenuity and energy has responded successfully to a variety of challenges. There is no reason to think that the challenge of the North will find Canadians deficient in effective ideas and resolution of purpose.

TELECOMMISSION

Study 8(d)

Multiservice Cable Telecommunication Systems – The Wired City

The Department of Communications

Study 8(d)

MULTISERVICE CABLE TELECOMMUNICATION SYSTEMS

THE WIRED CITY

Available by mail from Information Canada, Ottawa,
and at the following Information Canada bookshops:

HALIFAX
1735 Barrington Street

MONTREAL
1182 St. Catherine Street West

OTTAWA
171 Slater Street

TORONTO
221 Yonge Street

WINNIPEG
393 Portage Avenue

VANCOUVER
657 Granville Street

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Price: $1.25 Catalogue No. Co41-1/8D

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Information Canada
Ottawa, 1971

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This Report was prepared for the Department of Communications by a project team made up of representatives from various organizations and does not necessarily represent the views of the Department or of the federal Government, and no commitment for future action should be inferred from the recommendations of the participants.

This Report is to be considered as a background working paper and no effort has been made to edit it for uniformity of terminology with other studies.

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Mr. I. Switzer	-- Canadian Cable Television Association
Mr. A. Manson	-- CN/CP Telecommunications
Mr. F. Simpson	-- Department of Communications
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Mr. R. Lindsay	-- Trans-Canada Telephone System
Mr. G.J. Overtveld	-- Trans-Canada Telephone System
Mr. R. Christie	-- Western Canada Telecommunications Council

Submissions from Participants

The following organizations made formal submissions to Telecommission Study 8(d). Requests for copies of these submissions should be addressed to the respective originators.

1) The Canadian Broadcasting Corporation
2) The Canadian Cable Television Association
3) Canadian National/Canadian Pacific Telecommunications
4) The Electronics Industries Association
5) The Trans-Canada Telephone System

In addition the project team prepared a technical background report for the study, entitled "Fundamentals of Telecommunication Over Non Radiating Cable Media". This report is available on request from the Telecommission Registry.

Summary

Object

This investigation has been initiated to provide the Federal Department of Communications with information that will help establish telecommunication policy and legislation, in order to ensure the optimum evolution of telecommunications in Canada over the next three decades.

Content

It is one of fifty comprehensive studies of the Telecommunications Commission (Telecommission) on all aspects of telecommunications in Canada. This particular study investigates the present state of cable telecommunication systems in Canada. It explores the probable evolution from existing systems to future systems that could provide "total" telecommunication for Canadian cities. In addition the study considers the impact of multiservice cable telecommunication systems on urban areas, as well as the implications and advantages of substituting telecommunications for transportation.

The single most important application of new telecommunication technology will be in the cities and urban areas to alleviate problems of continuing population concentration

and traffic congestion due to the increased transportation requirements. It is quite clear that these trends cannot continue indefinitely and without bound, in fact the pollution problems created by the automobile and careless waste disposal are already starting to seriously affect Canadian cities, notably Toronto and Montreal.

The Wired City

There has been so much speculation over the past few years that the expression "Wired City" is rapidly becoming meaningless. In this report, "Wired City" means a city with a telecommunication system that provides a number of services. The sort of "Wired City" is determined by the type of telecommunication system used and the kind of services that it can carry.

At the present time, all Canadian cities have telecommunication systems that provide telephone, data and television service. Thus Canadian cities are already "Wired Cities".

In the future, the expression "Wired City" will mean a city with more than the conventional telecommunication or television (CATV) system. In fact it is already customary to consider a "Wired City" as a city with "total" telecommunication systems. Here "total" is used to imply that the number

of services that the system could provide is limited only by the imagination and pocket-book of the subscriber.

This study considers only civilian telecommunication systems over the time-frame of 20 years. Military and other special purpose systems are not considered.

Intra-City Systems

This report begins with a review of the present status of telecommunication (telephone/data) and CATV systems in Canada. Next, an analysis of user needs, and types of services that might be provided on intra-city cable telecommunication systems circa 1985-1990 is presented. Then techniques that might be used to realize these systems are discussed. Certain problems arising in the transition of existing systems into future multi-service cable systems are also discussed.

It should be emphasized that, as far as the period 1970-1990 is concerned, many predictions about exotic telecommunication systems for the city are not likely to materialize. The reasons for this are not really technical, but economic and social. Sophisticated multi-service telecommunication systems will be extremely costly; existing systems have to be written off at the correct

rate. The average subscriber may find no use for a computer capability in his home, and in addition certain services might be deleted because of some undesirable social side effects.

The technology to be used in the synthesis of multiservice telecommunication systems over the next 20 years is known. Present indications are that the multiservice telecommunication systems of the Canadian "Wired City" circa 1985-1990, will be switched cable systems (possibly utilizing a combination of coaxial cable and copper pairs). These systems will be capable of accommodating many more services than existing telecommunication or CATV systems.

Political, social and economic readjustments which might be required to implement any multiservice cable system are not considered, since this report is concerned only with technical feasibility.

Assumptions

The basic assumptions used in this report may be summarized as follows:

1. User needs produce a natural classification of the services into low, medium and high information rate categories, with service being either unidirectional or bi-directional.

2. Only existing technologies are considered (large scale integrated circuits, coaxial cables, etc.).
3. Government policy, legislation, and regulation will encourage the transition process from existing systems.
4. The trend in increasing population growth will be maintained and the demand for telecommunication services will continue to increase.

<u>Possible Multiservice Cable Telecommunication Systems</u>

The technology at this time indicates several possibilities in terms of future types of cable telecommunication systems. These are:

Systems utilizing

1. Multiple paired wires, each carrying single analog signals (as in the local distribution facilities of the present telecommunication system).
2. Sets of coaxial cables each carrying multiple analog signals. For this purpose the frequency division multiplex (FDM) technique would be used to combine signals.

3. Sets of coaxial cables each carrying multiple digital signals. For this purpose the time division multiplex (TDM) technique would be used to combine signals.
4. Sets of coaxial cables each carrying multiple digital and analog signals. The digital signals are used for low information rate services (such as telephone) and the analog signals are used for high information rate services (such as CATV).
5. Hybrid combinations of multiple paired wires and coaxial cables carrying analog and/or digital signals.

Digital systems offer signficant advantages in versatility for low and medium information rate services (such as voice, data transmission, videophone, facsimile, etc.) The present high cost of digital systems will be reduced by at least one order of magnitude with the use of large scale integrated circuits. In addition a unified digital system would be the natural choice for the optimum realization of a nation-wide computer utility structure.

Analog systems, on the other hand, offer the most efficient use of the spectrum in the case of non-digital high information rate services.

It is becoming more apparent that steps must now be taken to ensure the optimal interaction of telecommunication and computer systems. The present sophistication of telecommunication systems is largely due to the use of computers as functional elements. The future potential of computers will be greatly enhanced by the utilization of advanced telecommunication systems in making computing power available on a widespread basis. On the other hand, present telecommunication systems are narrow-band and have been optimized for voice traffic. Thus if the concept of the "Computer Utility" and a fully "Wired Canada" is ever to come to pass, a broadband multiservice system will be required.

Non-Technical Problems

Any multiservice cable system will give rise to regulatory and legislative problems, such as: ownership of the system itself, of terminal equipment, cables, amplifiers, etc. provision of service, the rate structure, performance and compatibility standards, maintenance of equipment, etc.

Since these questions were not part of the terms of reference for this study, they are not considered in this report.

Introduction

Eighty percent of the people of Canada live on less than ten percent of the land area. One hundred years ago 80 percent of the people lived in rural areas and the other 20 percent in the cities. The latter situation is now reversed. There has been a growing tendency for man to cluster in cities since the time of the industrial revolution, because these areas have been prime centres of employment and provided better standards of living. With the advent of multiservice telecommunication systems, it may be possible for men to enjoy again the advantages of living in less congested areas, and at the same time have at their disposal facilities for work, entertainment and other needs.

Multiservice telecommunication systems can provide not only means of developing new life patterns for city dwellers, but also solutions to many of the ills of urban living. Through the planned use of such systems, urban dwellers will be able to enjoy ordered, well defined and harmonious surroundings. They will have the opportunity of participating in society in a manner never before possible.

Present technological indications are that the intra-city telecommunication systems likely to be available in the 1980's will be

switched broadband cable telecommunication systems. It is conceivable that such systems could be used by city planners to establish small, self-contained communities within or around large cities. The establishment of multiservice telecommunication systems may prove to be an absolute necessity if Canada is to find solutions to problems of pollution, urban traffic, intra- and inter-city transportation, etc. For example, such systems could offer facilities for people to work at home, or at specially designed "electronic work-centres" near their home, reducing substantially the need for further development of high capacity mass transit systems.

The increase in air, rail and automobile traffic, which is geared to the population growth, is likely to be maintained. The present practice of adding to the transportation facilities cannot continue indefinitely, for reasons of space limitation and pollution of the environment. An effective substitute for travel could be the use of sophisticated telecommunication facilities to create "pseudo-transportation". The telecommunication companies plan to add two way videophone service to their existing system, and this should be available on a widespread basis in the late nineteen seventies. Then the planned combination of video/voice/data services can in many instances be used as effective substitutes for physical travel, both in space as well as in time.

Another reason for the planning of multiservice telecommunication systems is the financial community's estimate that in the 1980's, almost all financial transactions will be conducted by electronic means.

The impact of telecommunication systems on our social and economic well being is so important that purely technological considerations cannot and should not be the sole guides for their future development. The implementation of future telecommunication systems will either aggravate or ease the many problems encountered in various fields of human communication, education, transportation, etc. In some cases, it may even create new problems that are difficult to evaluate, such as the threat to individual freedom from centralized data banks.

Sometimes the effects of telecommunication systems are quite direct and obvious. In particular, McLuhan's views on the effects of TV have become clichés of the day.

These effects may be quite indirect and subtle. For example, the effects of TV programming on a listener's intellectual and social attitudes cannot be directly assessed. Nevertheless, if future intra-city multiservice telecommunication systems are to be beneficial, they will need to be more complex and sophisticated than the present telecommunication and CATV systems.

Existing Telecommunication Systems

The telecommunication system shown in figure 1 provides telephone and data services, and is the telecommunication system which at present makes Canadian cities qualify as "Wired Cities".

In any telecommunication system, the services that the system provides to users are achieved through the transmission of electrical signals. Every service, that is every particular signal, takes up a certain amount of spectrum. The number of services that could be provided is limited by the spectrum capability of the system. The spectrum of a given system is sometimes referred to as its usable bandwidth. These electrical signals can either be in analog form, in digital form, or they can be hybrid.

In order to appreciate what is involved in the operation of a telecommunication system, it is convenient to consider the system as consisting of four basic parts. These are:

long haul transmission facilities;

switching facilities;

local distribution facilities; and

terminal facilities.

The synthesis of a cable telecommunication system involves tradeoffs between switching, transmission, distribution and terminal facilities. In addition, consideration has to be given to the type of signal processing to be used; this determines

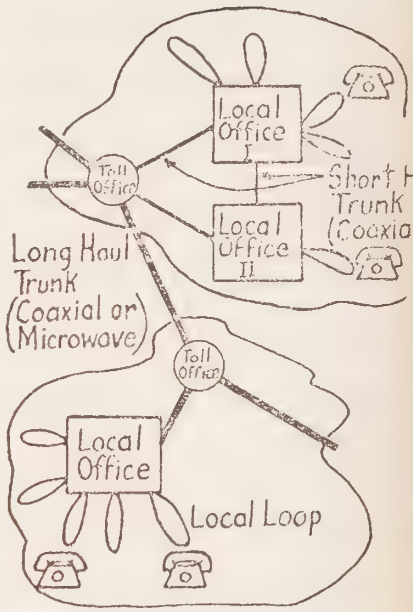
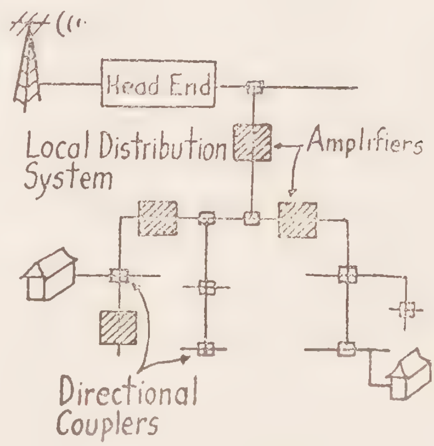


Fig. 1

whether or not the electrical signals should be in analog or digital form, and how they should be combined (multiplexed) on the cable system. It determines whether frequency division multiplexing (FDM), time division multiplexing (TDM), or some combination of both should be used.

In the typical telecommunication system of figure 1, subscribers are connected to local switching offices via pairs of copper wires called "loops". These local offices are then connected to toll offices by multipaired cables. Long haul transmission facilities consisting of coaxial cables or microwave relays interconnect the various toll offices. The subscriber terminals are telephone sets, or teletype units and computers when data is being handled by the system. At the present time the electrical signals travel through the telecommunication system in analog form, and frequency division multiplexing techniques are employed to separate them.



CATV System
Fig. 2

The cable television system of figure 2, on the other hand, has no switching facilities. It uses coaxial cable for local distribution. There are at present no long haul transmission facilities interconnecting CATV systems. The terminals are television sets at the subscriber's dwelling, and antennas, amplifiers, mixers, etc. at the "headend". The signals travel through the system in analog

form, and frequency divison multiplexing techniques are employed to separate them.

In addition to their different topological structures, other technical differences exist between the various cable systems, such as the rate at which the information can be transmitted, and its directionality. Information rates can be low, medium or high, and the direction of information flow can be uni-directional (as in CATV) or bi-directional (as in telephony). Table I summarizes these characteristics and presents some typical examples.

Table I

Directionality	Information Rate	Typical Example
Uni-Directional	Low	Meter Reading
	Medium	Radio
	High	CATV
Bi-Directional	Low	Telephone Telex/TWX
	Medium	Computer to User, User to Computer, Videophone
	High	Computer-to-Computer

In the not too distant future, the typical user will require much closer integration of the various services that will become available (videophone , bi-directional educational televison, computer aided instruction, etc.). Thus planners of future telecommunication systems must provide for versatility and adaptability to user demands for additional services as well as for the phasing out of services that have not received public acceptance.

<u>The First Principle</u>

Once "integrative versatility" is accepted as the first principle, the next consideration is the choice of the best transmission medium. At present, there is increasing congestion of the radio spectrum within certain cities. The broadcasting industry is the main user of this spectrum, but many channels are also allocated to mobile radio. Telecommunication and CATV systems in a city use the non-radiating medium of pairs of wires or coaxial cable. The choice of a transmission medium, radiating or non-radiating, is dictated by the following:

<u>Choice Transmission Medium</u>

a) Suitability of the medium for the service required (telecommunication with aircraft requires use of the radio spectrum).

b) Availability of spectrum (as mentioned above the radio spectrum is already overcrowded in certain cities).

c) Relative cost (with due regard to system versatility).

The radio spectrum is becoming so scarce in certain cities that (b) is possibly the most important consideration. It suggests the choice of a non-radiating transmission medium for city applications, provided that (a) and (c) can be satisfied.

<u>The Second Principle</u>

This report accepts as the second principle the necessity of non-radiating media for urban telecommunication systems.

<u>The Third Principle</u>

The third principle is the assumption of a date in the mid-nineteen-eighties for the implementation of multiservice cable telecommunication systems on a national scale. Considering the time scale required for the conversion of new technologies into mass production, the assumed target date for possible implementation eliminates any serious consideration of more exotic telecommunication systems and techniques. This leads to the fourth principle, namely that the only technologies considered are those which at present

<u>The Fourth Principle</u>

are sufficiently near to the mass production stage to allow for their widespread use in the nineteen eighties.

The cost of new multiservice cable telecommunication systems, or the capital requirements for converting existing telecommunication and CATV systems to multiservice systems are of primary importance. These costs and capital outlays cannot be estimated without first defining in some detail the proposed systems. This report, therefore, is mainly concerned with technical feasibility and system description, and not with actual cost details. It is unrealistic, if not impossible at this time, to assign monetary values to the differences in flexibility, maintainability, adaptability, reliability and many other characteristics between present and future cable systems and associated services.

The problem of capital investment in present systems is inescapable. For example, the telecommunications industry has a $7 billion investment at stake in existing facilities, which has to be taken into account in the planning and development of future multiservice telecommunication systems.

Telecommission Study 6(d) is directly related to the present study. It was conducted

in the form of an invitational seminar sponsored by three Federal Government departments and held at the University of Ottawa in June 1970. Participants and panelists from Universities, Government and Industry explored some of the social, political, economic and technical problems associated with the realization of "total" telecommunication systems for Canada over the next 15 to 20 years. The report of the Seminar will be published along with the other Telecommission Reports.

The concept of the future "Wired City" has caught the imagination of many, but for this ideal to become a reality, considerable readjustment of the present balance in the telecommunications industry will be required.

Needs, Services and System Properties

Telecommunication systems are designed to provide services corresponding to estimated subscriber needs and demands. There is a direct relationship between a given service and the properties of the system providing it. In order to establish this relationship, it is necessary to analyze subscriber needs, and have a thorough understanding of the system's properties.

With the implementation of new systems made available through advanced technology, specific details of many of the needs that will develop cannot now be foreseen. Therefore, it is essential that any system be so designed as to permit its ready adaptation to new demands for more and different types of services, and this adaptability should continue over a long period of time.

Subscriber Service

A subscriber service provides a connection between points in a system such that the subscribers can exchange information through their respective terminal devices. The typical example is the

telephone service. The nature of the connection is temporary, that is switching facilities are utilized for a limited period of time, and then are released for use by other subscribers. This sharing of switching facilities keeps costs down, but limits the number of subscribers that can be served at any given time. Thus one important characteristic of this type of system is its traffic handling capability.

System Properties

Two other major characteristics of a telecommunication system are information rate and directionality. The information rate can be low (Voice/Data), medium (Videophone), or high (Television), and the directionality uni- or bi-directional. Information rate is usually expressed in terms of bandwidth (in Hertz) for analog signals, and in bit rate (in bits per second) for digital signals.

The term "bauds" is often used to refer to the rate of a transmission line. It normally indicates the signalling rate used in the line, not the capacity of the line. It refers to the number of times the line condition changes per second. If the line condition represents the presence or absence of one bit, then the signalling rate is the same as the information rate, in bits per second. If, however, the line can be in one of four possible

states, then one line condition represents two bits instead of one. If it can be in eight possible states, each state condition represents three bits, etc.; one "baud" may be equal to one or more bits depending on the number of coding states possible on the line.

Table 1 summarizes the information rates of some existing services.

Table 2

Information rate	Maximum bit rate	Typical Type of Service
Low	50K bits/sec	Telex/TWX voice
Medium	7M bits/sec	Videophone
High	50M bits/sec	Television

The maxima indicated in Table 2 assume no redundancy is removed from the signal. Reduction factors of 5 to 10 are theoretically possible, but are costly at present.

Cable Telecommunication Services

The following types of services are subscriber services that have different system characteristics.

CATV Service

CATV service is area selective, transmission is one way, the signal is analog, and no switching is involved other than channel selection at the subscriber end. The information is in the form of moving picture and voice, and its rate is high.

A certain amount of signal processing is usually involved, because it is often necessary to translate the frequencies of certain channels received off-the-air. Other than this the signal is simply amplified to an adequate level at various locations, and the bandwidth of each channel is identical with the bandwidth of the received signal, (i.e. approximately 6 MHz).

The distances involved in typical CATV systems are relatively short (typical long trunks are of the order of 20 miles, using 50 to 60 amplifiers) because of the degradation of the signal in passing through each amplifier. Amplifiers are required at approximately every 2,000 feet along the cable.

Telephone Service

Telephone service is point selective, involves highly sophisticated switching, the signal is analog, and the transmission is two way and symmetrical. The information is in the form of voice, and its rate is low.

Although the information remains in analog form, the signal may be processed many times when two subscribers talking with each other do not live in the same exchange area. The switching centres are highly developed in the major cities, and they provide facilities for direct long distance dialing with automatic recording of the toll charges.

<u>IRTV Service</u>

Information Retrieval by Television is a typical example of the new type of services that are becoming available. Audio-Visual programs are requested from a central film and videotape library by telephone, and transmitted to television monitors in schools via coaxial cables. The information rate is low and bi-directional on one medium, but high and uni-directional on the other.

This system is in fact a hybrid system, creating a greater potential utilization of the cable distribution system through the use of the telephone and an information library as a complement. It is feasible to include a two way voice channel on the cable, but this would only be practical if all the transmission facilities were to be dedicated.

The information has to be transformed into a form suitable for television viewing. It is then transmitted as a video signal if the cable is dedicated, or translated to one of 12 television channels if the same cable provides the service to many locations.

Data Service

Data service is at present provided over telecommunication facilities. Transmission can be one way or two way, the information rate low or medium, and the service dedicated or switched.

Because the service is provided over voice channels, the information is usually transmitted in analog form, using amplitude modulation or phase shift modulation (frequency shift keying). MODEMs (MODulator-DEModulators) are necessary at both ends of the telecommunication facilities.

The rapid growth of data service has completely altered the predicted pattern of telephone service growth, and in some areas, in New York in particular, the traffic load is far greater than had been predicted for the present. This is an example of how technological progress can create needs that are difficult to predict and evaluate.

In terms of system parameters, data service is more compatible with wideband coaxial cable than narrow band copper pairs. With appropriate coding, a large number of data channels could be carried on a single coaxial cable, without interfering with each other. The necessary data processing and switching equipment is at present expensive, but large scale integration techniques will be bringing the cost down in the foreseeable future.

Correspondence Between Type of Service, and System Properties.

The number of subscriber services which could be provided by a total telecommunication system is very high. For example a preliminary list of 117 services drawn up at the Stanford Research Institute is included at the end of this section. This list classifies the various services in terms of specific system properties.

It should be emphasized that many of these services, though technically feasible, may never obtain public acceptance. Some, obviously, will cater only to a limited number of subscribers, and will be offered at a price. This list is included

to emphasize the relation between type of service and system properties. It is instructive to note that 88 of these services require a central computer or library for data storage. This shows the close relation that will eventually exist between telecommunication systems and computers.

Of the services listed, 77 require two-way low information rate, 26 require one-way high information rate and two-way low information rate, and eight require high information rate both ways.

A large number of these services could be provided on existing telecommunication facilities, but if they were made available in too short a period of time, they would greatly tax the traffic handling capabilities of these facilities and possibly degrade the quality of many of the existing service offerings. If it is judged that new services are desirable and that they would receive public acceptance, it might not be sufficient to add them on the existing facilities; a certain amount of re-designing would have to be done as, for example, is the case for the proposed picturephone service, which might be provided by a six wire or coaxial

cable system. In fact, no existing system could provide two way high information rate services on a national scale. If a new system was to be planned to meet such a demand, it could easily be designed to accommodate additional one-way or two-way services of low and medium information rates.

A number of existing telecommunication companies have expressed an interest in a pilot project of a multiservice cable telecommunication system. In particular, Bell Canada is considering the possibility of dedicating four pairs of copper wires, as well as a pair of coaxial cables to each dwelling in the Erin Mills New Town development project in Toronto, their object being to experiment with new service offerings. In addition a number of other telecommunication companies, for example Maritime Telephone and Telegraph, and British Columbia Telephone Company, have expressed similar interests. CATV companies have expressed a desire to be designated as telecommunication common carriers, and thus be able to enter into the telecommunication business.

Table II, taken from the Rostow report, presents another list of telecommunication services likely to become available in the future. The system parameters are limited

to information rate and directionality.

Table II

Service	System Parameters	
Advertising	l, m, or h	1
Alarm (burglar, fire, etc.)		1
Banking		2
Facsimile	m	1 or 2
Emergency Communications		1 or 2
Communication between Computers	l, m, or h	2
Mobile Communications		2
Teletype Communications		2
Computer - time sharing		2
Meter Reading (Utilities)		1
Home Shopping	l, or m	1 or 2
CATV	h	1
IRTV	l, or m	1 or 2
Telephone		2
Computer Aided Instruction (CAI)		2
Videophone	m	2
Voting		2
Vehicle Traffic Control	l, m or h	1 or 2

l = low rate

m = medium rate

h = high rate

1 = one way

2 = two way

Further Comments On The Requirements For Various Services

The telecommunication systems of the future will be different from the present systems in the following manner:

1. Multiplicity of services.
2. Increased traffic handling capability.
3. Increase in the number of medium and high information rate services.
4. Increase in the number of two way services.

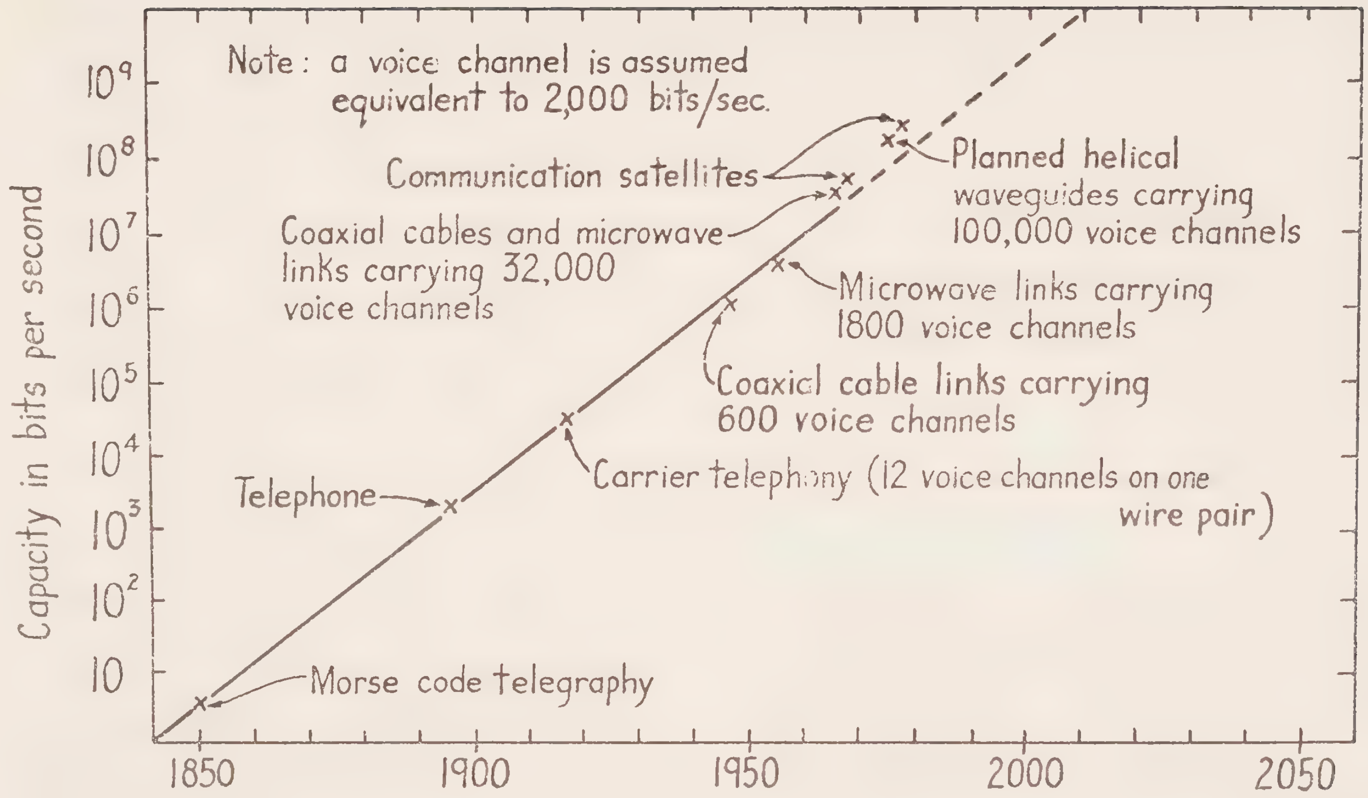
The increase in the number of two way services is expected to be particularly dramatic in medium and high information rate types. This will affect significantly the traffic handling requirements of future telecommunication systems. In particular, the cost and complexity of switching facilities will increase considerably.

Some new services will surely become available, such as home movies on demand, facsimile, computer-aided instruction, etc. Also, experts in computer science are forecasting that the interconnection of large computers may be necessary to solve very complex problems. These services have a high information rate, of the order of that of a television channel, and

will require a wideband medium for transmission and distribution.

At the present time, coaxial cable is most attractive as an intra city distribution medium, and it is expected that it will be used in ever increasing quantities in local trunks and distribution facilities of future telecommunication systems.

Figure 3 shows the evolution of telecommunication services by the time periods that have elapsed between the introduction of various services of increasing information rates. The services are specified in terms of their voice channel capability, but the vertical axis has been calibrated in terms of their overall information rate, in bits per second.



Evolution of the telecommunication services

Fig. 3

List of Services	TWO WAY	SYMMETRIC	POINT TO POINT	AREA SELECTIVE	VOICE/DATA	T.V. TYPE DISPLAY	ONE WAY	CENTRAL COMPUTER/ LIBRARY
Business - Work at Home								
1. Secretarial assistance	X	X	X		X			
2. Person-to-person communications	X	X	X		X			
3. Computer-assisted meetings	X	X	X		X			
4. Electronic mail				X	X		X	X
5. Adding machine functions	X	X	X		X			X
6. Access to company files	X	X	X		X			X
7. Message recording					X			X
Business - Commerce								
8. Shopping transactions	X		X		X	X		X
9. Grocery price list(information and orders)	X	X	X		X			X
10. "Cashless society"transactions	X	X	X		X			X
11. Dedicated newspaper	X	X	X		X			X
12. Banking	X	X	X		X			X
13. Answering services	X	X	X		X			X
14. Real estate listings	X		X		X	X		X
15. Better Business Bureau	X	X	X		X			X
16. Special sale information	X		X		X	X		X
17. Budget preparation and monitoring								X
Political								
18. Council meetings, other local meetings				X		X	X	X
19. Voter views and participation	X	X	X		X			X
20. Nationwide voting surveys and voting	X	X	X		X			X
21. Debates on local issues	X	X	X			X		X

List of Services	TWO WAY	SYMMETRIC	POINT TO POINT	AREA SELECTIVE	VOICE/DATA	T.V. TYPE DISPLAY	ONE WAY	CENTRAL COMPUTER/ LIBRARY	
Political cont'd.									
22. Free political channel for candidates	X			X	X	X		X	
23. Access to elected officials	X		X		X	X		X	
Social Services - State and Federal Governments.									
24. Social Security	X	X	X		X			X	
25. Immigration and naturalization	X	X	X		X			X	
26. Taxes	X	X	X		X			X	
27. Weather Bureau Information	X		X		X	X		X	
28. Courts	X	X	X		X			X	
29. Index of social services	X	X	X		X			X	
30. General Postal Information	X	X	X		X			X	
31. Welfare	X	X	X		X			X	
32. Vocational counseling	X	X	X		X	X		X	
33. Employment service	X	X	X		X			X	
34. Disaster warnings and evacuation control	X	X		X	X			X	
35. Marriage counseling	X	X	X		X	X		X	
Health									
36. Remote diagnosis	X	X	X		X	X		X	
37. Emergency medical information	X		X		X	X		X	
38. Drugs	X	X	X		X			X	
39. Health insurance	X	X	X		X			X	
40. Medicare claim processing	X	X	X		X			X	
41. Prescription communication (doctor-to-pharmacy.)	X	X	X		X			X	
42. Dietetic meal planning and scheduling	X	X	X		X			X	
43. Ambulance/doctor/hospital coordination	X	X	X		X			X	
44. Outpatient services	X	X	X		X			X	
45. Medical and dental appointments and reminders.	X	X	X		X			X	

List of Services

Health Cont'd.	TWO WAY	SYMMETRIC	POINT TO POINT	AREA SELECTIVE	VOICE/DATA	T.V. TYPE DISPLAY	ONE WAY	CENTRAL COMPUTER/ LIBRARY
46. Advice on simple problems	X	X	X		X			X
47. Doctor directory	X	X	X		X			X
48. Immunization information	X	X	X		X			X
49. Mental Health center(psychiatric consultation)	X	X	X		X			X
50. Suicide prevention center	X	X	X		X			X
51. Alcoholics Anonymous	X	X	X		X			X
Household								
52. Water, electric, and gas meter reading	X	X	X		X			X
53. Alarm systems	X	X	X		X			X
54. Operate household services (turn lights on, light up furnace, etc).	X	X	X		X			X
55. Recipe file	X	X	X		X			X
56. Telegrams	X	X	X		X			
57. Mail and messages	X	X	X		X			
58. Daily calendar (reminders about appointments).	X	X	X		X			X
59. Address book	X	X	X		X			X
60. Equipment maintenance reminders	X	X	X		X			X
61. Christmas lists	X	X	X		X			X
62. Generate shopping lists,weekly menu .	X	X	X		X			X
63. Cleaning information	X	X	X		X			X
64. Food storage information	X	X	X		X			X
65. Keeping track of food supply,household items.	X	X	X		X			X
Agriculture								
66. Soil conditions	X	X	X		X			X
67. Fertilizers	X	X	X		X			X
68. Insecticides	X	X	X		X			X
69. Gardening	X	X	X		X			X
70. Seasonal crops	X	X	X		X			X
Education								
71. Correspondence schools	X		X		X			X
72. Computer tutor	X	X	X		X			X

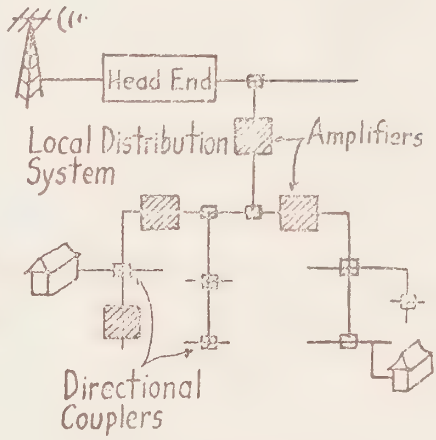
List of Services	TWO-WAY	SYMMETRIC	POINT TO POINT	AREA SELECTIVE	VOICE/DATA	T.V. TYPE DISPLAY	ONE-WAY	CENTRAL COMPUTER/ LIBRARY
Education Cont'd.								
73. Computer-aided instruction	X	X	X		X			X
74. School-related communications	X		X		X	X		
75. College catalog and related information	X	X	X		X			X
76. Adult courses, evening courses	X		X	X		X		
77. Seminars	X			X		X		
78. Consultation with teachers, professors	X	X	X		X	X		
Transportation - Travel								
79. Department of Motor Vehicles	X		X		X	X		X
80. Road conditions	X		X		X	X		X
81. Travel advice	X		X		X	X		X
82. Traffic conditions	X		X		X	X		X
83. Vehicle maintenance reminders	X	X	X		X			X
84. Taxi service	X	X	X		X			
85. Bus route scheduling, flight and train schedules	X	X	X		X			X
86. Maps	X		X		X	X		X
87. Travel accommodations	X	X	X		X			
88. Fares and ticket reservation	X		X		X	X		
89. Tour information	X		X		X	X		
90. Travel and car insurance	X	X	X		X			
91. Passports	X	X	X		X			
Recreation								
92. Skiing (snow conditions)	X	X	X		X			
93. Camping (areas, facilities)	X		X		X	X		
94. Tennis (courts, partners)	X	X	X		X			
95. Golfing (courses etc)	X		X		X	X		
96. Picnic Areas (facilities available)	X		X		X	X		
97. Flying (lessons, airports)	X		X		X	X		
98. Fishing (season, permit, etc)	X		X		X	X		
99. Hunting (season, permit, etc)	X	X	X		X			

List of Services	TWO-WAY	SYMMETRIC	POINT TO POINT	AREA SELECTIVE	VOICE/DATA	T.V. TYPE DISPLAY	ONE-WAY	CENTRAL COMPUTER/ LIBRARY
Recreation (Cont'd)								
100. Boating	X		X		X	X		
101. Hobbies	X	X	X			X		
102. Games (Chess, bridge)	X	X	X		X	X		
Entertainment								
103. Current cultural events	X			X	X	X		
104. Local plays, movies	X	X	X		X			
105. Ticket reservations	X	X	X		X			X
106. Restaurant reservations	X	X	X		X			X
107. Computer dating	X	X	X		X			X
Information - General								
108. Index of all services available	X	X	X		X			X
109. Library	X	X	X		X			X
110. Dictionaries	X	X	X		X			X
111. Encyclopedias	X	X	X		X			X
112. Expanded yellow page service	X	X	X		X			X
113. Stock market information	X	X	X		X			X
114. Newspapers	X	X	X		X			X
115. Magazines	X		X		X	X		X
116. Recent book publications (lists and abstracts).	X	X	X		X			X
117. Telephone area codes	X	X	X		X			X

Existing Cable Telecommunications Systems

Community Antenna Television Systems

Cable television systems or Community Antenna Television (CATV) systems (figure 4) as they are usually called, receive television and FM signals off-the-air from broadcasting stations and distribute these signals via coaxial cables to their subscribers. These systems in effect provide a one way broadband service. Each subscriber pays an initial installment charge (approximately $15.00) and a monthly charge (approximately $5.00).



CATV System
Fig. 4

In September 1969, there were approximately 317 CATV systems in Canada serving over 926,000 households (over 22 per cent of the urban households in Canada). This represents a 45 per cent increase over the number of subscribers in 1968. These CATV systems employ about 1,400 people and in 1968 had a revenue of over $30 million. At present more than 35 CATV systems provide additional programmes on a closed circuit basis. The total investment in CATV plant in Canada is of the order of $100 million.

Limitations of Existing CATV Systems

The present CATV distribution systems are not readily adaptable to bi-directional transmission. They distribute simultaneously many televison and FM broadcast stations using frequency division multiplexing techniques.

Existing CATV systems are capable of accommodating 25 to 30 TV channels. However,

there are a number of problems associated with the provision and utilization of this high channel capacity. First, the operators of CATV systems in Canada find that their reception is limited to eight to 10 off-the-air channels. To provide additional channels on a closed circuit basis requires large expenditures for programming and costly studio equipment which cannot be supported by a small CATV operation. In addition the average (Canadian) home receiver is of VHF type and is capable of receiving only 12 channels. This receiver limitation can be overcome in various ways; nevertheless any proposed solution will have to pass the tests of economic viability and public acceptance.

Future of CATV Systems

The additional capacity of CATV systems can be used to provide educational services to schools, training hospitals and other educational institutions. Although this has been proposed, there are many technical and management compatibility problems to be solved before it becomes a reality.

Another extension of the present CATV system could be the inclusion of a dial-up service for special programmes. There are many other wide band uni-directional services that could be provided on CATV type systems. Although these services would not require any modifications to

the layout of the existing CATV network, modifications will be required to the electronic components of the system. In particular the amplifiers would have to be capable of providing the number of channels desired, and adapters would be required at certain reception points to distribute specific services to the selected subscriber(s).

Telecommunication Systems Owned and Operated by Telephone Companies

In Canada there are 13 major telephone companies, that own and operate approximately 2,000 intra-city telecommunication systems. The Telephone Association of Canada (established in 1921) and the Trans-Canada Telephone System (established in 1931) oversee the operation and interconnection of these systems. The Canadian Telephone Industry employs over 75,000 people, has an investment in facilities of over $6.5 billion, and an annual revenue of over $1 billion. In addition the telephone companies own over 70 per cent of all the coaxial cable that is used in CATV systems. This represents about 50 million feet of cable.

Limitations of Existing Telecommunication Systems

The present telecommunication systems owned and operated by the telephone companies, although highly developed and employing sophisticated switching techniques, utilize pairs of

copper wires in their local distribution facilities. These wires have relatively small spectrum capabilities compared to coaxial cables, and are thus suitable for handling voice and low speed data signals only. That is, existing telecommunication systems are narrow-band (less than 50 KHz), and are designed and optimized for voice telecommunication. They employ analog signal processing techniques, and therefore, are not natural candidates for handling digital data, transmission.

<u>Future of Telecommunication Systems</u>

The projections of Bell Canada as presented to the Canadian Transportation Commission rate hearings in 1968 are summarized in <u>Table 3.</u> They are used here to illustrate the possible transitions that a telephone company owned telecommunication system is likely to undergo.

<u>Data Handling Capabilities</u>

From these projections it can be seen that the capabilities of future telecommunication systems will be increased to provide for medium speed (50 Kb/sec) data telecommunication. Furthermore, it is expected that by 1988, Touch Tone telephones will make up about 40 per cent of the total number of telephones in Canada, thus providing simple data input terminals.

<u>Videophone Capabilities</u>

Videophone service promises to remove the distance restriction for face-to-face meetings, much the same way as telegraph removed it for the written word and telephone for the spoken word.

The telephone companies envisage their video system developing initially as an adjunct to their existing telecommunication system, sharing the same long haul and local distribution facilities.

Certain telephone companies are considering dedicating either a pair of coaxial cables or three pairs of copper wires for local distribution followed by a gradual introduction of videophone services over the next 10 to 15 years. The use of six wires per subscriber would transform telephone company telecommunication systems into 1 MHz switched systems, capable of providing both videophone and a variety of other medium speed services. The use of coaxial cable in place of copper pairs would transform the system into a 300 MHz switched system capable of "total" telecommunication.

<u>Future Video Type Capabilities</u>

The Bell System in the U.S. is experimenting with various computer display schemes designed to be compatible with the videophone. It is possible to envisage a videophone incorporating special display capabilities allowing interactive use with computers. The development of equipment for making permanent copies, and the inclusion of colour in the video service, present challenges for the future.

Telecommunication Systems Owned and Operated by Canadian National/Canadian Pacific

Canadian National (CN) Telecommunications and Canadian Pacific (CP) Telecommunications started pooling their resources in 1947 to become CN/CP Telecommunications. The CN/CP although not a member of the Trans-Canada Telephone System (TCTS) is a well established telecommunications company which provides telephone and data services in a number of Canadian cities. At present CN/CP employ 4600 people with an investment in telecommunication facilities of over $0.5 billion (as against the $6.5 billion TCTS one) and have an annual revenue of over $95 million.

It should be noted that a large portion of the local distribution in the CN/CP system is leased from telephone companies.

A detailed description of the switched data services offered by CN/CP is given in Table 6.

Data Telecommunication Systems

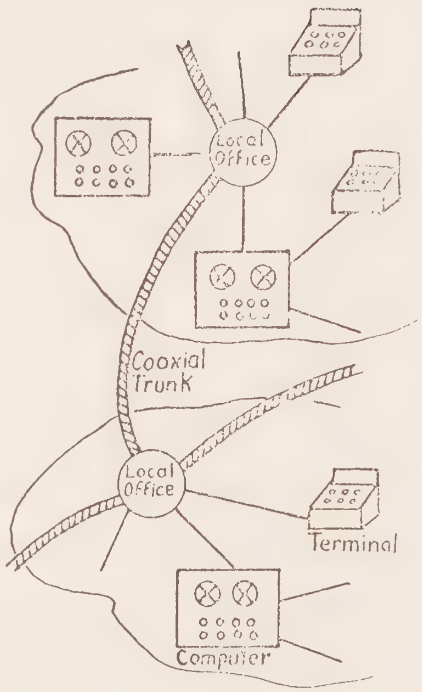
With the advent of time-sharing techniques for digital computers and the advances in telecommunication technology, new entities called "Computer Utilities" are emerging. The concept of a computer utility, dictates that each user be provided via a telecommunication system with the equivalent

of a private computer capability whenever and wherever required.

Initially, all data processing companies were privately owned and connected to subscribers via rented telecommunication facilities. Recently a number of telecommunication systems have started providing data services.

In present data processing systems, most if not all subscriber terminals, are of the low speed (typically 100 words per minute) type. In the future there will likely be increasing use of higher speed terminals incorporating computer graphic, video, CRT capabilities. To connect such terminals to remotely located computers, will require high speed (broadband) telecommunication facilities.

A set of interconnected computers that are accessible from remote terminals is referred to as a Multi-Access Computer System (see Figure 5). There are many possible tele-communication/computer architectures for a computer utility, but the trend seems to be towards configurations as shown in Figure 5. The dimensions of such a system would depend on:



Multi-Access Computer System

Fig. 5

1) The location and number of computers and terminals.
2) The type of telecommunication system used for data telecommunication.

At present, most of the data telecommunication is done via existing telecommunication facilities. These facilities were originally designed for voice traffic and its low bandwidth (4 KHz) requirements. Thus there are well defined data rates (bit rates) that can be achieved. Therefore, all existing Multi-Access Computer Systems have to adjust their input - output speeds to those of their telecommunication facilities.

There are additional problems whenever data communication is attempted on lines designed for voice traffic. It can be shown that for data communication over telecommunication facilities, the efficiency of utilization of a given channel as a percentage of total utilization time of the channel is of the order of 2 - 5 per cent. At the present time, one method used to increase the efficiency of data communication over telecommunication facilities involves the use of a computer as a multiplexer - concentrator.

Tables 4 and 6 indicate the types of data telecommunication facilities available from Bell Canada and CN/CP. Tables 4 and 6 show at present telecommunication facilities can (in parts) carry data at speeds of 50 K bits/sec. Table 5 shows the hierarchy of present and planned digital (Bell Canada) high capacity systems for the period 1970-1980.

Regardless of how the Computer Utility for Canada will be achieved, the ultimate data/telecommunication system configuration of the Utility will be dictated by whether or not there should be centralization of computer facilities, and whether there should be a relatively small number of large computers or a large number of relatively small computers. The Science Council of Canada recently set up a study group to investigate certain problems related to the anticipated widespread use of computers, and their report should be available shortly. In addition, most of the studies of section five of the Telecommission are devoted to computer systems and associated problems.

Ownership

The question of who should provide the telecommunication facilities as well as the computer hardware and software for the Computer Utility is outside of the terms of reference for this study. One choice is the existing telecommunication industry, which already has a $7 billion

investment in facilities, and which is almost entirely Canadian owned. The pros and cons of their entry have been made to Parliament in a Department of Communications report: "Participation by Telecommunication Carriers in Public Data Processing". It should be noted here, that the telecommunication company CN/CP is already in the public data processing field, and the pros and cons of permitting this company to continue to offer such services is discussed in the above-mentioned report.

PROJECTED GROWTH OF BELL CANADA TELECOMMUNICATION SYSTEM

TABLE 3

	Total Telephones (millions)	Number Touch Tone Telephones (Data Sets) (millions)	(in percent of lines in service)			Expected Long Haul Circuits	Long Haul Facilities (excluding Satellites) (in percent of long haul circuits)				Short Haul Trunk (percent of circuits)		
			Step by Step	Cross-bar	Elect-ronic		Cable Carrier	Coaxial Cable	Open Wire Carrier	Micro-wave	Phy-sical* Circuits	Non Phy-sical or Coaxial	Micro-Wave
1970	6	.4	53%	39%	8%	13,000	5%	0	1%	94%	80%	16%	4%
1978	8.9	3.3	30%	40%	30%	49,000	1%	8%	0	91%	4%	92%	4%
1988	12.8	10.5	--	36%	64%	148,000	0%	21%	0	79%	5%	90%	5%

* Physical implies more than 1 circuit per pair of wire

BELL CANADA FACILITIES FOR DATA SERVICE

TABLE 4

Name of Service	Bit rate; K bit/sec	Availability	Charges		Remarks
			Inter-city	Intra-city	
Dataphone	2	Presently	rental of private line	normal long distance charges	a) 1/2 Duplex transmission b) There are more than 2000 Dataphone sets used in Networks and Dedicated facilities
Dataline I	2.4 to 4.8	Presently	Access line charge of $100 per month, 10¢ per minute for distances up to 350 miles	10¢ a minute for distances up to 350 miles	a) Full Duplex; four wire transmission b) There are more than 150 Access lines in Canada.
Wideband	50	Mid 1970	No Rates Finalized To Date		a) Full Duplex; six wire transmission. b) The service will be offered in major Canadian cities. c) The wide band switches will have a 1 MHz capability for videophone.

COMMON CARRIER DIGITAL SYSTEMS FOR CANADA - (BELL CANADA)

TABLE 5

Name of Carrier System	Type of Cable	Bit Rate M bit/sec	Availability	Remarks
T_1	Copper pairs	1.5	Multiplex equipment and line presently available	24 voice channels
T_2	Coaxial or special type of paired wires	6	no plan to make a special line for this carrier (multiplex equipment available 1974)	a) one picturephone channel b) could be used to transfer 250,000 words each 60 bits long, from one computer to another in 2.5 seconds c) this is faster than the highest data transfer rate from today's magnetic tapes and disks
T_3	Coaxial	46	no plans to make a special line for this carrier (multiplex equipment available 1977-1980)	a) one black and white TV channel b) could be used to transfer 250,000 words each 60 bits long from one computer to another in 320 milli-seconds
T_4	Coaxial	281	Multiplex equipment as well as line (cable) will be available 1977 - 1980	a) 6 black and white, or 3 colour TV channels b) could be used to transfer 250,000 words each 60 bits long from one computer to another in 50 milli-seconds c) the bit rate of 281M bit /sec compares with the internal processing rate of 600M bit/sec of todays very fast computers. This rate of 600M bit/sec is very close to the limit imposed by the transit time of signals on wires inside the computer.

CANADIAN NATIONAL - CANADIAN PACIFIC

FACILITIES FOR SWITCHED DATA SERVICE

TABLE 6

NAME OF SERVICE	BAUD RATE	AVAIL-ABILITY	CHARGES INTER-CITY	CHARGES INTRA-CITY	REMARKS
Telex	50	Now	10¢ to 90¢ per minute depending on distance	10¢ per minute	Serves 20,000 subscribers in Canada; conforms to CCITT standards for connection to 300,000 subscribers in Europe and also inter-connects with 30,000 telex subscribers in the United States and Mexico
Data/Telex	Any code or speed up to 180 baud	Now	10¢ to 90¢ per minute depending on distance	10¢ per minute; or $20. per month flat rate for computer time sharing	Generally used for intra-company service. Equipment provided for DC or EIA interface. Permits customers to connect a variety of equipment to computers at any code or speed up to 180 baud.
Broadband Exchange Service 4KHZ	600 to 4800 baud	Now	Termination Charges $100. per mongh plus usage charges starting at 10¢ per minute depending in distance & speed of transmission	$100. per month plus 10¢ per minute usage charge	Four wire operation throughout permits two way simultaneous transmission of data. Can be provided on two wire basis for voice communication.
Broadband Exchange Service 108 KHZ	50,000 baud	Now	Rates quoted on request	Rates quoted on request	Switches have capability for switching frequencies up to 108 KHZ; typical use on microwave group (60-108KHZ) would provide 50 K bit service.

Future Multiservice Cable Telecommunication Systems

In this section, multiservice cable telecommunication systems are discussed from a point of view of their general structure. In principle, these systems should be "total" telecommunication systems capable of providing more services than existing systems and readily adaptable to new and different service offerings.

A "total" telecommunication system could provide: telephone, videophone, television, radio, computer, facsimile and utility metering services, to each home (see Figure 6). The various services provided on such a telecommunication system, can be divided into three classes:

1. Broadcast

   Commercial and Instructional TV

   Commercial and Instructional Radio

2. Real Time Point to Point

   Telephone

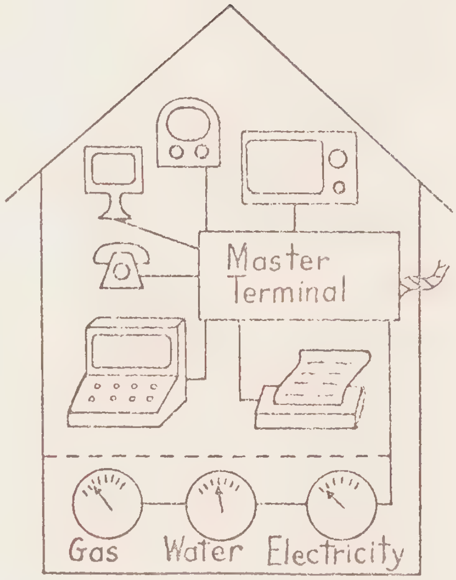
   Videophone

   Telegraph and Teletype

   Certain Computer Services

3. Store and Forward

   Computer Services (time sharing and instruction)



Subscriber Services
Fig. 6

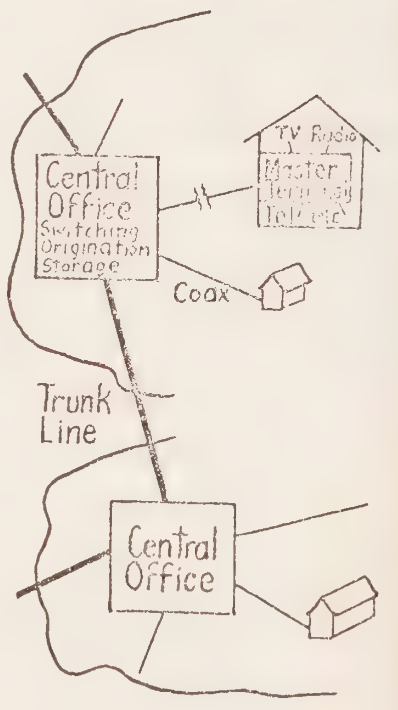
Facsimile (newsprint and magazines, library access)

Financial Transactions (banking and remote purchasing)

Interrogating (polling and meter reading)

Mail

To achieve these capabilities for each home a switched multiservice cable telecommunication system would be required. As has been previously pointed out, although existing telecommunication systems are highly developed and employ sophisticated switching, they have been optimized for voice telecommunication, and are, therefore, not a natural choice for data telecommunication. They are also narrow band in that they utilize pairs of copper wires to provide service to each home. This use of copper wires limits the usable bandwidth of the overall system and in effect the number of services that can be simultaneously provided on it.



Switched Coaxial-Cable System

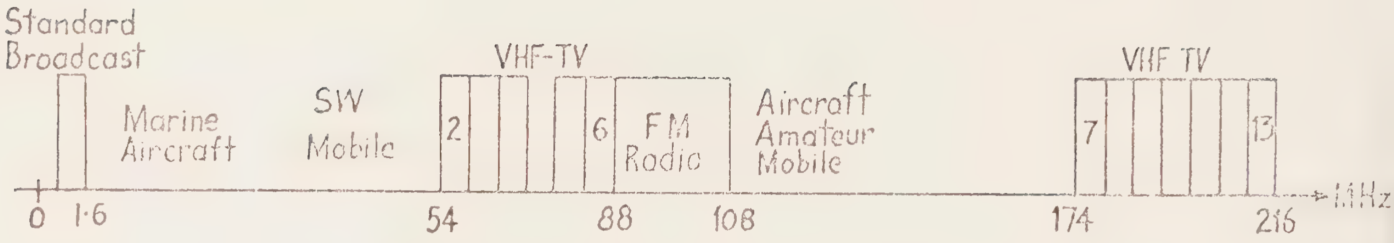
Fig. 7

Switched Coaxial Cable Telecommunication Systems

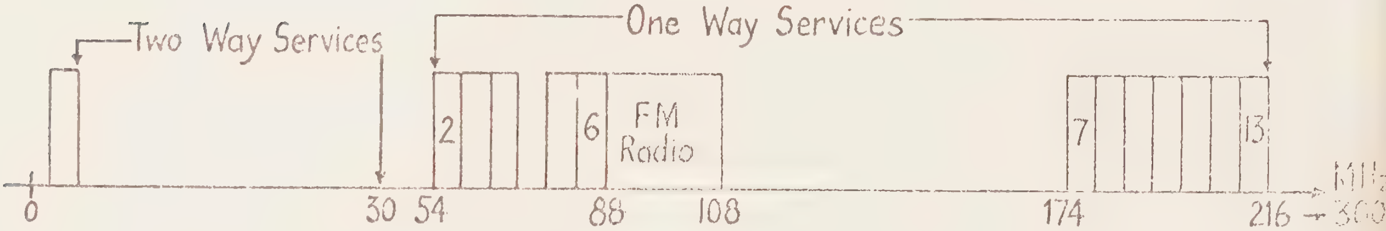
The bandwidth of existing telecommunication systems could theoretically be increased substantially if their copper pairs were replaced by coaxial cables. The resulting system would be a switched coaxial cable system (see Figure 7). It could be capable, with the use of suitable

signal processing, of providing "total" telecommunication services to each home. This system has the same philosophy of operation as existing telecommunication systems, but with the additional feature that it has a usable bandwidth two orders of magnitude greater. Therefore, it could accommodate many more services. Some idea of the bandwidth gained by the use of coaxial cable can be obtained from Figure 8 which compares the spectrum (usable bandwidth) of a typical coaxial cable with the Department of Communications allocation of the Radio Spectrum and with the usable bandwidth of a typical copper pair.

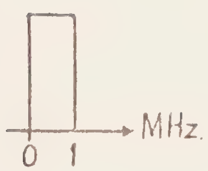
If existing telecommunication systems were to evolve into switched coaxial cable systems, all Canadian cities would become "totally Wired Cities". It would be possible to build into such systems varying degrees of sophistication and complexity, depending on the type of signal processing used. The most sophisticated systems would be the ones in which all the signals are digital and time division multiplexing techniques are used. Furthermore, the use of computers for switching and for the performance of many other logical functions would make these systems very flexible. In addition such systems would allow the separation of hard-



D.O.C. Allocation of the Radio Spectrum



Possible Coaxial Cable Spectrum Allocation



Usable Spectrum of Typical Copper Pair

Fig. 8

ware (the system itself) from the software (the type of services the system provides).

The centralization of hardware in a national telecommunication system has a number of advantages and disadvantages from non-technical points of view. Since these considerations are outside of the terms of reference of this study, they are not pursued further here.

To convey some appreciation for the large costs involved in the establishment of a multiservice telecommunication system the example shown in Figure 7 will be used. In order to provide the following capabilities to each home:

4 voice/data channels;

12 TV channels, one-way-area selective;

12 TV channels, one-way-subscriber selective;

4 TV channels, two-way-area selective;

an investment of the order of $5,000 per subscriber would be required, assuming a density of 500 subscribers per square mile. This corresponds to ten times the cost of providing only telephone service. Another way of putting this is, instead of a $7 billion investment as in the existing telecommunication facilities an investment of the order of $70 billion would be required to provide

such a system for the entire country.

The above example illustrates one possibility for a switched coaxial cable system that has the configuration of the existing telecommunication system. The advantage of this type of system is that it can be realized by superimposing a coaxial cable structure on the existing paired wire facilities without interrupting the existing service, and then changing over when the new plant is installed.

There are of course many other possibilities for multiservice coaxial cable systems. The wide bandwidth of the coaxial cable allows the trade-off of bandwidth for switching. In fact other configurations of multiservice cable systems have been proposed. For example, the Rediffusion system "Dial a Programme" (figure 9), utilizes a distribution system containing many cables, with each cable carrying a single 6 MHz channel. This type of system reduces the number of amplifiers for a given distance, but increases the length of cable required to service a given area. A subscriber is connected to the system via a single cable, and a local switching arrangement which allows the selection of a particular cable in the trunk.

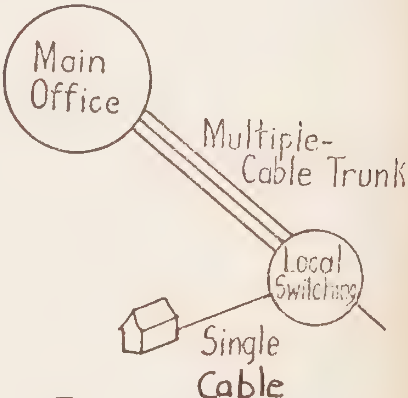


Fig. 9

The system in figure 8 could provide high speed data on one of the cables in its trunk, high quality video on another, and the switching could be set up to allow any subscriber access to all or any given selection of the cables in the trunk. The construction costs for such a system would vary with the number of cables in the trunk, the type of signal processing used and the types of service provided.

Either of the systems of figure 7 or figure 9 could be used to provide "total" telecommunication. The technology required for the implementation of these systems is now well known and it would be possible to realize them, on a national scale, within 10 to 15 years.

Limitations of the Human Receiver

Man finds himself in the middle of an information explosion, in which the computer far exceeds his abilities to calculate; telecommunication channels already deliver far more information than his brain can process and absorb, and this information capacity of telecommunication systems is increasing almost without bound. The limitations of the human as a receiver and processor of information is illustrated in Table 7. This Table shows the channel capacities to the brain possessed by the eye and the ear, as compared with the potential capacities of a single

video (TV) telecommunication channel.

Information Carrying Capacity of Telecommunication Channel	Information Carrying Capacity of Human Channels	Processing Capacity of Human Brain From all Sources
Audio = 10K bits/sec Video = 50M bits/sec	Ear = 10K bits/sec Eye = 1M bit/sec	40 bits/sec

Table 7

A preliminary inspection of Table 7 indicates that a large amount of the capacity of a single TV channel cannot be exploited for video transmission to humans because of the 40 bit/sec processing capacity of the human brain. It is indeed for this reason that there is so much redundant (repetitive) transmission in the ordinary broadcast television signal. In fact all audio/visual equipment intended for human use is constrained in its ultimate information carrying capacity by the processing limitations of the human brain and the channel capacities of the ear and eye that provide the input to the brain.

Terminal Equipment in Multi-Service Telecommunication Systems

Terminal equipment must be compatible with and in principle an extension of human

senses. Hearing and vision are, and will remain the most important senses that can be extended by the use of present and foreseeable telecommunication systems. In addition, for bi-directional services, terminal equipment must have transmitting and receiving capabilities.

<u>Audio Terminal Equipment</u>

The variety of audio services available in multi-service cable telecommunication systems will increase in the future, but the rate of total growth will remain approximately as at present. The total volume of these services will be dominant, but fortunately, the required bit rates are low, and expensive terminals are not required.

<u>Video Terminal Equipment</u>

The demand for visual telecommunication will undoubtedly increase with the introduction of videophone and computer visual displays.

The technical requirements for television type visual display and those for alphanumeric character displays (information retrieval, computer output, etc.) are not at present compatible. The former has poor resolution but is excellent for real time moving picture display. The latter must have high resolution, but the real time aspect is usually unimportant. The "universal" display capable of producing both quality graphical displays and a moving colour TV picture is not available at present.

Video Recording Equipment

Video recording equipment allows recording for later playback. It can be considered a large capacity high speed memory system. There are presently various types of video recorders available, but they are continually being refined and modified, and are expensive. The price of home entertainment units is still relatively high ($600-$800).

Character Generators
"ROM" Memories

Visual display terminals will likely incorporate character generators that permit the writing of alpha-numeric characters on a screen. These characters are stored in a read only memory (ROM), the price of which is gradually decreasing with continuing technical advances in solid state technology and more widespread usage.

Hard Copy

"Hard copy" capabilities for visual display terminals are just becoming available, but are still in an early stage of development, and expensive. It is expected that there will be an increasing use of facsimile type devices that can produce both line diagrams and alpha-numeric text.

The Substitution of Telecommunication For Transportation

The similarities between telecommunication and transportation systems have been known for a long time. These similarities are both topological and functional. Both these two systems provide contractions in the space/time frame.

Although there has been considerable progress in each of these two fields, they continue to develop independently. It is becoming more evident that if problems of urban living are to be successfully tackled, there will have to be closer interaction between the disciplines of telecommunication and transportation. Hopefully this interaction will generate radically new techniques for the planning, design and implementation of future cities as well as for urban renewal in existing ones.

The concept of substituting telecommunication for transportation is not new. Progress in this field has been continuous ever since man started using smoke signals to carry messages over long distances. In fact, all telecommunications are substitutes for travel in time, if not in space. Today many possibilities exist for substituting electronic telecommunication for travel in space as well as in time. Compared to individual income,

the cost of transportation is rising, and that of telecommunication can be expected to decrease. At the same time the sophistication of electronic telecommunication systems is increasing, and it is, therefore, desirable to determine as soon as possible the extent to which substitution can be made, and what effects it would have on our lives.

The benefits of substitution will depend not only on the appreciation of what substitutions are technologically possible but also, and just as important, on whether such substitutions are economically, sociologically and psychologically desirable. A challenge for the future will be to develop a multidisciplinary approach for studying and modelling those substitutions that are feasible and desirable.

The Promise For The Future

The next three decades will see man in a continuous transition away from a largely mechanical environment dependent on transportation towards a telecommunication one, in which his experiences will be increasingly based on the use of electronic devices. This transition will profoundly alter (for better or worse) the shape and characteristics of most of our ways of life.

BIBLIOGRAPHY

Books

1)	J.R. Pierce	Symbols, Signals and Noise Harper and Row 1961.
2)	C. Cherry	On Human Communication MIT Press 1966.
3)	L. Kleinrock	Communication Nets McGraw Hill 1964.
4)	W. Rheinfelder	CATV System Engineering TAB books, June 1967.
5)	E. Rostow	Reports PB 184-412 and 184-413. June 1969 Presidents Task Force on Communications Policy.
6)	N. Abramson	Information Theory and Coding McGraw Hill 1963.
7)	J. Singh	Information Theory, Language and Cybernetics Dover 1966.
8)	Conover - Mast Publications	The Communications Revolution Science and Technology (Special Issue) April 1968.
9)	Bell Telephone Laboratories	Transmission Systems for Communications Bell Laboratories publication 1964.
10)	T. Crowley,G.Harris, S. Miller,J. Pierce, J. Runyon	Modern Communications Columbia University Press 1967.
11)	J. Martin	Telecommunications and the Computer Prentice Hall 1969.
12)	M. Rubin,C.Haller	Communication Switching Systems Rheinhold Publishing Corp. 1966.
13)	H.Kahn,A.J.Wiener	The Year 2000 The MacMillan Company 1967.
14)	H.W. Gilmore	Transportation and the Growth of Cities The Free Press, Glencoe, Illinois 1953.

15)	W.R. Bennett J.R. Davey	Data Transmission McGraw Hill 1965.
16)	M. Schwartz W. Bennett, S. Stein	Communication Systems and Techniques McGraw Hill 1966.
17)	S. Golomb	Digital Communications Prentice Hall 1964.
18)	R. Meier	The City As A Communication System MIT Press
19)	D.F. Parkhill	The Challenge of the Computer Utility Addison Wesley 1966.

Papers

1)	Dominion Bureau of Statistics: (Canada)	Community Antenna Television Cat. No.56-205, January 1970.
2)	Canadian Radio-Television Commission	Ruling No.397, December 1969.
3)	Bell Canada	Exhibits B-72 to B-80 filed at the Canadian Transportation Commission rate hearings 1968.
4)	J. Palmer	CATV Systems - Design Philosophy and Performance Criteria for Specifying Equipment Components IEEE transactions on Broadcasting Vol. BC-13, No.2, April 1967.pp 57-68.
5)	C.F. Buster	Total Communications Via The Coaxial Cable United States Department of Agriculture; Rural Electrification Administration, January 1968.
6)	A.S. Taylor	The Future of Cable TV IEEE Spectrum, November 1969.
7)	F. Belt	Television 20 years from Now Electronics World, January 1970.
8)	R.P. Gabriel	A Comparison of Wired and Wireless Broadcasting For The Future Paper presented to the Royal Television Society, February 9th, 1968.
9)	Rediffusion Ltd.	Dial a Programme Rediffusion Bulletin No.86, Christmas 1969.
10)	R.P. Gabriel	Dial - A - Channel CATV System Broadcast Management/Engineering February 1970.
11)	Electronics Industries Association	EIA filing to the FCC. Docket No.18397, Part V, October 27th 1969.
12)	J.Pierce, P.Goldmark, H.Olson, J.Dersaur D.Engelbart, N.Johnson	Six Sages View The Future of Communications Electronics, November 24, 1969.

13)	H. Barnett E. Greenberg	A Proposal For Wired City Television. Rand Corporation, August 1967.
14)	Dominion Bureau of Statistics	Telephone Statistics Cat. No. 56-202 and 56-203 December 1969.
15)	R.L. Davis	New Wideband Data Communication Services. Datamation, June 1969.
16)	A. Lester	The Future of Communications presented to the Hamilton Association, Hamilton, Ontario January 10, 1970. (Available From Bell Canada).
17)	Telephone Association of Canada.	Canada's Telephone Industry in Perspective 1966.
18)	Trans-Canada Telephone System	Notes on Planning January 1969.
19)	J.P. Molnar	Picturephone Service - A New Way of Communicating Bell Laboratories Record May / June 1969.
20)	F.W. Memmott	The Substitutability of Communications For Transportation Traffic Eng. Journal, February 1963.
21)	T.J. Healey	Transportation or Communications IEEE Transactions on Communication Technology Vol. Com 16 No.2, April 1968.
22)	Kaiser Aluminum News	Telemobility - When Far Is Near Kaiser Aluminum News, Vol 3 1966.
23)	J.C.R. Punchard	What's Ahead in Communications IEEE Spectrum, January 1970.
24)	G. Thompson	Moloch or Aquarius (Available from The Northern Electric Co., Ottawa)
25)	Department of Communications	Telecommission Study 4(a). July 31st 1970
26)	Department of Communications	Participation By Telecommunication Carriers In Public Data Processing July 1970.

27)	K. Fischbeck	Communications Tappi, September 1968 Vol 51 No.9.
28)	Department of Communications	Proceedings of the Seminar of Telecommission Study 6(d) on The Wired City.
29)	J. de Mercado	The Wired City Canadian Telephone and Cable Television Journal, May 1970.
30)	R.M. Fano	The Place of Time Sharing Engineering Education, April 1968.
31)	J.R. Pierce	Communication Science Journal, October 1967.
32)	R. Lee Smith	The Wired Nation. The Nation, May 18th 1970.
33)	D. Kaye	Cable TV: Slumbering Electronic Grant-A Multibillion Industry? Electronic Design, April 12, 1970

Appendix

Terms of Reference For Telecommission Study 8(d).

This appendix contains copies of the "Original" terms of reference which was written at the beginning of the study in August 1969. After the preliminary report of Study 8(d) was prepared in March 1970, the Project Team modified the "Original" and produced a "Revised" terms of reference which more precisely defined the investigation and considerations for the Final Report.

TERMS OF REFERENCE
FOR A TECHNICAL STUDY OF
"SPECIAL SERVICES PROVIDED BY WIDE BAND INTRA CITY CABLE DISTRIBUTION SYSTEMS"

GENERAL

The Department of Communications is entrusted with the responsibility to ensure the optimum development of telecommunication services in Canada.

Advances in coaxial cable technology continue to make practical an ever increasing variety of telecommunication services. It is necessary now to re-examine the whole area of coaxial cable systems so that a realistic assessment of their potential can be made. The development of multi purpose shared services coaxial cable systems promises high quality, effective and efficient means of communication previously unimaginable. The rapid advances in research and development since the 1950's and the growing convergence of a host of communication services present a number of serious problems which have to be resolved before coaxial cable systems can truly come into their own. Foremost among these problems are those of design, construction and operation of such cable systems, what services are possible and feasible and when these services could be made available.

In order to get a continuous and realistic projection of the future of coaxial cable systems the Department requires current, accurate and authoritative information on technological problems which arise from the use of coaxial cable systems to provide a number of different services. Specifically the Department has to know what coaxial cable systems are technologically possible, what they will cost and the type of services they could provide.

TERMS OF REFERENCE

In order to accomplish the objectives outlined above, a number of specific requirements have to be met. Specifically, the Department has to ascertain:-

(1) What is the true potential with respect to type and quantity of shared services that could be provided within a city on a common coaxial cable system, with the present and anticipated technology?

(2) What is the structure of multi-purpose coaxial cable systems that could simultaneously provide many one way and two way services?

(3) What is the construction costs for such systems?

(4) How could multi purpose coaxial cable systems tie into existing and proposed inter city telecommunication facilities?

Revised

Terms of Reference
for
Telecommission Study 8(d)

General

The Department of Communications is entrusted with the responsibility to ensure the optimum development of telecommunication services in Canada.

Advances in cable technology continue to make practical an ever increasing variety of telecommunication services. It is necessary now to re-examine the whole area of cable telecommunication systems so that a realistic assessment of their potential can be made. The development of multi-purpose shared services cable systems promises high quality, effective and efficient means of communication previously unimaginable. The rapid advances in research and development since the 1950's and the growing convergence of a host of communication services present a number of serious problems which have to be resolved before cable systems can truly come into their own. Foremost among these problems are those of design, construction and operation of such cable systems, what services are possible and feasible and when these services could be made available.

In order to get a continuous and realistic projection of the future of cable telecommunication systems the Department requires current, accurate and authoritative information on technological problems which arise from the use of cable systems to provide a number of different services. Specifically the Department has to know what cable telecommunication systems will be technologically possible, the type of services they could provide, and their impact on and use in alleviating congestion in other physical transportation and communication systems.

Terms of Reference

In order to accomplish the objectives outlined above, a number of specific requirements have to be met. Specifically, the Department has to ascertain: -

(1) What is the state of existing cable telecommunication systems in Canada with respect to their physical structure, limitations and capabilities?

(2) What is the structure of optimum multi-service cable telecommunication systems that could simultaneously provide many one way and two way services?

(3) What is the relationship between services and system properties?

(4) What is likely to be the impact of advanced telecommunication technology on other types of physical communication as well as its possible uses in solving urban congestion problems?

(5) How could the transition of (1) to (2) above, occur?